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Rahul Kumar
Department of Soil Science and Agricultural Chemistry, IGKV, Raipur, Chhattisgarh, India

Correspondence
Rahul Kumar
Department of Soil Science and Agricultural Chemistry, IGKV, Raipur, Chhattisgarh, India

Response of different genotype and cutting height of rice stubble on yield and nutrient uptake in lathyrus under utera cropping system in vertisol

Rahul Kumar

Abstract
A field experiment conducted at instructional farm IGKV, Raipur during rabi season 2014-15 to study the Influence the different genotype and cutting height of rice stubble on, yield and yield attributing characters and nutrient uptake in Lathyrus under rice-pulse relay cropping system in vertisols. The lathyrus genotype Ratan was found superior over Prateek, Mahateora and Local genotypes in respect of growth characters; yields attributes and yield under rainfed rice-utera system. Cutting height of rice stubble under lathyrus with 30 cm cutting height recorded higher seed and stover yield than 15 cm cutting height under rainfed rice-utera condition. The lathyrus genotypes Ratan gave better result over the Prateek and Mahateora with 30 cm cutting height of lathyrus under utera cropping. The soil moisture depletion was fast in local cultivar over Ratan and Prateek and moisture conservation was resulted higher in cutting height of rice stubble 30 cm over 15 cm cutting height.

Keywords: Lathyrus, Rice, Stubble, farmer practice, Improved practice

Introduction

Lathyrus (*Lathyrus sativus* L.) or grass pea, popularly known as '*khesari*' is a very hardy pulse crop capable of growing in extreme moisture stress condition. Grass pea has been cultivated in South Asia and Ethiopia for over 2500 years and is used as food and feed. It is a popular drought tolerant crop grown in drought-prone areas of Africa and Asia. Its ability to provide economic yield under adverse conditions has made it a popular crop in subsistence farming in many developing countries and it offers great potential for use in marginal low rainfall areas. Despite its tolerance to drought, grass pea is not affected by excessive rainfall and can be grown on land subject to flooding (Sinha, 1980) [29]. Pulse crop production, occupies 23.47 M ha area with production of 18.44 million tones and productivity of 785 kg ha-1 in India. It is extensively grown in Chhattisgarh, Madhya Pradesh, Bihar, West Bengal, Maharashtra and parts of eastern Uttar Pradesh. It is also known as *khesari*, *teora*, *lakh* and *lakhadi* in India, *guaya* in Ethiopia, *san li dow*in China and *pois care* in France. It is a *rabi* season crop, mostly grown in October- November and harvested in late February or early March. It grows abundantly in dark loamy or sandy- loam soils.

It contains high protein 31.9% (Tomar *et al.,* 2011) [33]. It is used as *dal* and its flour is consumed with other legumes or cereal flour. Pulses being the cheapest and economic source of protein have greater significance in the dietary system of vegetarian population besides help in maintaining soil fertility through biological nitrogen fixation. The productivity of pulse crops remains low due to which the availability of pulses declines to 37 grams capita-1 day-1 as against 70 grams capita-1 day-1 as recommended by WHO for a working youth. To meet out the short comings, there is an urgent need for increasing pulse production in the country. In the state of Chhattisgarh, it is grown in an area of 0.48 M ha with annual production of 0.32 M tones and productivity of 671 kg ha-1 (Anonymous, 2012) [3].

The excessive consumption of *Lathyrus* seed for prolonged periods of 3-4 months has been known to be associated with a crippling disease "lathyrism" which was endemic to certain parts of India (Ganpathy and Dwivedi, 1961) [5] and (Haimanot *et al*., 2005) [9]. The disease has been seen during famines when *Lathyrus* seed was the exclusive or main source of nutrients for extended periods. Research has shown that oxalyl-diamino-propionic acid (ODAP) concentration increases in plants grown under stressful conditions, compounding the problem.

The factor responsible for neurological disorder was isolated and characterized to be β-oxalylamino-L-alanine (Nagrajan *et al.,* 1963; Murty *et al.,* 1964) [17, 16]. Breeding programs are underway to produce lines with low ODAP. A few varieties (Ratan, Prateek, Mahateora etc.) with lower ODAP level have been developed by Indira Gandhi Krishi Vishwavidyalaya, Raipur which may be helpful in increasing lathyrus production in the country. It has a great promise in the rice fallows of north-eastern and central regions of the country. Lathyrus variety Mahateora is suitable for rainfed and *utera* (paira) cultivation and as irrigated crop in *rabi* late sowing of entire Chhattisgarh and M.P.

This variety is suitable for medium (*Dorsa*) to heavy (*Kanhar*) soils. Average yield of this variety is 10-14 q ha-1. Special characters of this variety are low ODAP content (0.07-0.08%), medium duration (90-100 days), non shattering, non lodging, highly nutritious, rich in protein 31.9%. It is also used as green and dry fodder for cattles and is tolerant to moisture stress condition. This variety has pink flower and could be easily differentiated from the land races as well as earlier released varieties.

Prateek is suitable for rainfed and *utera* cultivation and is irrigated crop in *rabi* late sowing of entire Chhattisgarh and M.P. Average yield of this variety is 9-12 q ha-1 (sole crop) and 6-9 q ha-1 (*utera).* Special characters of this variety are low ODAP (0.076 %) content, highly nutritious, protein rich (%) used as green and dry fodder for cattles and medium duration (110-115 days). It has moderate resistance to powdery and downy mildew, thrips and pod borers. Plant height range between 45-70 cm, semi erect, dark green foliage, profuse branching, medium to long leaves, blue flowers, responsive to fertilizer and irrigation. It is accepted to *dal* mills industry as it has high percentage of *dal* recovery. The farmers of Chhattisgarh are using seed rate of more than 100 kg ha-1 for sowing because of poor seed germination as well as less moisture available for seed establishment and some seeds are picked by birds. It is predominantly grown as a relay crop, popularly known as *utera,* in rice field, which is a well established popular rice-based cropping systems of Chhattisgarh and farmers do not have a better alternative under such a harsh rainfed condition.

Method and Materials

A field was conducted at farmer field of instructional farm IGKV as well as farmer field village Godi, Raipur (C.G) under plains of Chhattisgarh during the rabi season 2013. The place of investigation comes under dry moist, sub humid region. The region receives 1200-1400 mm rainfall annually, out of which about 88 percent is received during rainy season (June to September). The experimental soil was clay loam in texture, pH 7.14, EC 0.27 dSm-^{1}, organic carbon 0.61, available nitrogen 223.60 kg ha^{-1}, available phosphorus 14.70 kg ha^{-1}, available potassium 369.40 kg ha^{-1}. The design of the experiment was split plot design with three replication. The treatment included four genotype in main plot with two cutting height of rice stubbles 15 cm and 30 cm height. The experiment was laid out in eight treatment combinations. Nitrogen content in plant Sample was determined by using micro-Kjeldahl method as described by Chapman and Pratt (1961) [4]. Phosphorus content was determined by Vanadomolybdo-phosphoric acid yellow color method using blue filter as described by. Potassium content was determined by flame photometer method as described by Chapman and Pratt **(**1961) [4]. The growth and yield of lathyrus crop depend upon all growth parameters. viz plant height, number of branches, Dry matter accumulation, Number of nodules**,** Dry weight of nodules, Root length, Root volume, Dry weight of root**,** pod per plant, Number of grains pod-^{1}, Number of grains**^{1}**plant^{-1}, Test weight, Seed yield, Stover yield, Harvest Index, uptake of nitrogen, phosphorus, potassium, and bulk density with moisture depletion pattern in lathyrus crop under utera cropping.

Results

1. Plant height (cm)

Plant height of lathyrus was observed at 25, 50, 75 DAS and at harvest and data pertaining to plant height are presented in table 1. In general plant height increases progressively with the increase in the age of the crop due to their genetic characteristics and different growth habit of four genotypes. The plant height gained at relatively slower rate between 75 DAS to at harvest. Plant height of lathyrus significantly influenced by different genotypes and seed rates at all stages of observation except at 25 DAS. Significantly taller plants were observed with prateek as compared to other genotypes at all stage of observation except at 25 DAS. Variety prateek was comparable with genotypes Ratan in terms of plant height. Significantly taller plant was recorded under the seed rate of 75 kg ha-1 as compared to 60 kg ha-1 at all stages of observation except at 25 DAS. However, it was comparable with seed rate of 60 kg ha-1 at 50 DAS. The lower plant height was recorded with 60 kg ha-1 seed rate. The differences in plant height of lathyrus due to interaction of genotypes and seed rates was found non significant. Among the various lathyrus genotypes, prateek attained maximum plant height as compared to other genotypes and lower plant height was observed with genotypes Local which might be due to their genetics growth characters (Kashyap *et al*., 1991 and Sahu, 1991) [11, 22]. Achwait (1980) [1] reported that plant height increased significantly with increased rate of seeding from 50 to 100 kg seed ha-1.

2. Number of branches plant-1

Number of branches of lathyrus was observed at 25, 50, 75 DAS and at harvest and data is presented in table 4.3. In general number of branches plant-1 increased upto at 75 DAS. Number of branches of lathyrus significantly influenced by different genotypes and seed rates at all stages of observation except at 25 DAS. Among the various genotypes, prateek attained maximum number of branches as compared to other genotypes at all stages of observation whereas minimum numbers of branches plant-1 was observed with genotype Local. Similar observations have been reported by Sharma *et al.* (1989) [24], Kumar *et al.* (1997) [12], Soomrao and Khan (2003) [30], Singh *et al.* (2007) [21, 26, 27] and Singh and Sekhon (2007) [21, 26, 27]. Significantly higher number of branches was recorded under the seed rate of 60 kg ha-1 as compared to 75 kg ha-1 at all stage due to 25, 50, 75 DAS and at harvest. The differences in number of branches of lathyrus due to interaction of genotypes and seed rates was found non significant.

3. Dry matter accumulation plant-1 (g)

Dry matter accumulation plant-1of lathyrus was observed at 25, 50, 75 DAS and at harvest and its data are presented in table 4.4. It was observed that dry matter plant-1 increased upto the time of harvest of crop. The dry matter accumulation plant-1 of lathyrus significantly influenced by different genotypes and seed rate at all stages of observation except at 25 DAS. Among the various lathyrus genotypes, Prateek recorded significantly maximum dry matter accumulation plant-1 as compared to other genotypes except genotypes Ratan which was comparable with genotype prateek at all stages of observation. The minimum dry matter accumulation plant-1 was observed with genotypes Local. Zode *et al*. (1999) [35] reported that dry matter accumulation increased from 30 to 90 days after sowing (DAS), whereas, net assimilation rate was maximum at 50-70 DAS. The genotypes RLS-2 and PS-6 had the maximum dry matter accumulation, leaf area and absolute growth rate, but had minimum net assimilation rate. Among different seed rate, 60 kg ha-1 recorded maximum dry matter accumulation plant-1 as compared to the seed rate of 75 kg ha-1 at all stages of observation. The minimum dry matter accumulation plant-1 was recorded with seed rate75 kg ha-1. These results are in agreement with the findings of Zode *et al*. 1999 [35]. The differences in dry matter accumulation of lathyrus due to interaction of genotypes and seed rate was found non significant.

4. Number of nodules plant-1

Number of nodules plant-1 of lathyrus was observed at 25, 50 and 75 DAS and presented in table 4.6. It was observed that in general nodules plant-1 increased upto at 50 DAS. Reduction in nodules number was mainly due to its decay in later stages of crop. Number of nodules plant-1 of lathyrus significantly influenced by different genotypes and seed rates at all stages of observation except at 25 DAS. Among the lathyrus genotypes, Prateek attained maximum number of nodules plant-1 as compared to other genotypes at all stages of observation and minimum number of nodules plant-1 was observed with genotype Local. This result might be due to the various genotypes with their various genetic growth characters (Kashyap *et al*., 1991 and Sahu, 1991) [11, 22]. The increase in nodules number was probably due to increased aeration of rhizosphere in soil condition of lower plant population. Significantly higher number of nodules plant-1 was recorded under the seed rate of 60 kg ha-1 as compared to 75 kg ha-1 at all stages of observation. The differences in number of nodules plant-1of lathyrus due to interaction of genotypes and seed rates was found non significant.

5. Dry weight of nodules plant-1 (mg)

Dry weight of nodules plant-1of lathyrus was observed at 25, 50 and 75 DAS and data related to dry weight of nodules plant-1are presented in table 4.7. In general dry weight of nodules plant-1 increased up to at 50 DAS, but at 75 DAS, a decrease in dry weight of nodule was observed under all the genotypes and seed rates as they were exhausted up to this stage, with the advancement of plant growth, most of the nodules degenerated resulting in lesser dry weight. Dry weight of nodules plant-1 of lathyrus was significantly influenced by different genotypes and seed rates at all stages of observation except at 25 DAS. Among lathyrus genotypes, Prateek recorded maximum number of dry weight of nodules plant-1 as compared to other genotypes at all stages whereas it was minimum with Local which could be attributed to the genetic characteristic of the genotype. (Kashyap *et. al*., 1991 and Sahu, 1991) [11]. Increased dry weight of nodules might be due to more nodule count and greater infection of *rhizobium* in the growing roots. Similar results were also noted by Soomrao and Khan (2003) [30] and Singh *et al.* (2007) [21, 26, 27]. Significantly higher dry weight of root nodules plant-1 was observed under the seed rate of 60 kg ha-1as compared to 75 kg ha-1at all stages of observation except at 25 DAS. The differences in number of nodules plant-1 of lathyrus due to interaction of genotypes and seed rate was found to be non significant.

6. Root length plant-1 (cm)

Root length plant-1 of lathyrus was observed at flowering and at harvesting and data related to root length plant-1 are presented in table 4.8. Root length plant-1 of lathyrus was significantly influenced by different genotypes and seed rates both at flowering and at harvesting. Among lathyrus genotypes, Prateek gave maximum root length plant-1 as compared to other genotypes at flowering as well as at harvesting stage and minimum root length plant-1 was observed with genotypes Local. However, variety Prateek was comparable with genotypes Ratan and Mahateora at flowering and with genotypes Ratan at harvesting. This result might be due to the various genotypes with their various genetics growth character (Kashyap et. al., 1991 and Sahu, 1991) [11]. Similar results have been reported by Gurusaravanan *et al*. (2010) [8]. Among different seed rates, 60 kg ha-1 recorded significantly higher root length plant-1 over the seed rate of 75 kg ha-1 at both stages of observation. The differences in root length plant-1 of lathyrus due to interaction of genotypes and seed rates was found to be non significant.

7. Root volume plant-1 (cc)

Root volume plant-1 of lathyrus was observed at flowering and at harvesting and data related to root volume plant-1 is presented in table 4.8. Root volume plant-1 of lathyrus was significantly influenced by different genotypes and seed rates at both the stages of observation. Among the various lathyrus genotypes, Prateek had significantly higher root volume plant-1 over other genotypes at flowering and at harvesting stage and minimum root volume plant-1 was observed with genotypes Local. This result might be due to the various genotypes with their various genetic growth characters (Kashyap *et al*., 1991 and Sahu, 1991) [11, 22]. Similar results have been reported by Gurusaravanan *et al*. (2010) [8]. Among different seed rates, 60 kg ha-1 recorded significantly maximum root volume plant-1 as compared to the seed rate of 75 kg ha-1 at both stages of observation. The differences in root volume plant-1 of lathyrus due to interaction of genotypes and seed rate was found non significant.

8. Dry weight of root plant-1 (g)

Dry weight of root plant-1 of lathyrus was observed at flowering and at harvesting and data related to dry weight of root plant-1 are presented in Table 4.8. Dry weight of root plant-1 of lathyrus significantly influenced by different genotypes and seed rates at both stage of observation. Among lathyrus genotypes, prateek recorded significantly higher dry weight of root plant-1 as compared to other genotypes at flowering and at harvesting stage and minimum root volume plant-1 was observed with genotype Local. This result might be due to the various genotypes with their various genetic growth characters (Kashyap *et al*., 1990 and Sahu, 1991) [11, 22]. Similar results have been reported by Gurusaravanan *et al*. (2010) [8]. Among different seed rates 60 kg ha-1 recorded significantly higher dry weight of root plant-1 as compared to the seed rate of 75 kg ha-1at both stages of observation. The differences in dry weight of root plant-1 of lathyrus due to interaction of genotypes and seed rates was found non significant.

9. Number of pods plant-1

Data pertaining to number of pods plant-1 of lathyrus are presented in table 4.9. The results revealed that Prateek beard the highest number of pods plant-1 however, it was at par to that with genotype Ratan. The lowest number of pods plant-1 was recorded under genotype Local. Variation in number of pods plant-1 could be due to genetic character of genotypes. Similar observations have been recorded by Goswami *et al.* (1998) [7] and Singh and Sekhon (2007) [21, 26, 27]. As regards to seed rate, 60 kg ha-1 produced significantly higher number of pods plant- 1 as compared to that with 75 kg ha-1. Maximum number of pods plant-1 in seed rate of 60 kg ha-1 could be attributed to higher number of branches and flowers plant-1 due to adequate supply of soil-moisture and nutrients under optimum plant stand. The differences in number of pods plant-1of lathyrus due to interaction of genotypes and seed rates were found non significant.

10. Number of grains pod-1

Data pertaining to number of grain pod-1 of lathyrus are presented in table 4.9. The result revealed that genotype Prateek had significantly higher number of grains pod-1 over other genotypes. The lowest number of grain pod-1 was recorded under genotype Local. Variation in number of grain pod-1may be due to genetic character of genotypes. Similar observations have been recorded by Goswami *et al.* (1998) [7] and Singh and Sekhon (2007) [21, 26, 27]. As regards to seed rate, 60 kg ha-1 produced significantly higher number of grain plant-1 than the seed rate of 75 kg ha-1. Maximum number of grains pod-1 with seed rate of 60 kg ha-1 may be due to adequate supply of soil-moisture and nutrients under optimum plant population. The differences in number of grains pod-1 of lathyrus due to interaction of genotypes and seed rates were found non significant.

11. Number of grains plant-1

Data pertaining to number of grains plant-1 of lathyrus are presented in table 4.9. Which revealed that prateek proved to be the best in number of grains plant due to better podding and more number of grains pod-1? The lowest number of pods plant-1 was recorded under genotype Local. Variation in number of grains plant-1 may be due to genetic character of genotypes. Similar observations have been recorded by Goswami *et al.* (1998) [7] and Singh and Sekhon (2007) [21, 26, 27]. As regards to seed rate, 60 kg ha-1 produced significantly higher number of grain plant-1 than the seed rate of 75 kg ha-1. Maximum number of grains plant-1 under seed rate of 60 kg ha-1 may be due to genetic character of genotypes. The differences in number of grain plant-1 of lathyrus due to interaction of genotypes and seed rates were found non significant.

12. Test weight (g)

Data on hundred seeds weight (Test weight) are presented in table 4.9. Test weight of lathyrus genotype varied significantly being maximum with genotype Mahateora however, it was found at par with genotypes Ratan and prateek. Minimum test weight was recorded with Local. As regards to seed rate, the result revealed that the effect of different seed rate on test weight was found to be non significant. The differences in test weight of lathyrus due to interaction of genotypes and seed rates were found non significant.

13. Seed yield (q ha-1)

Data related to seed yield are presented in table 4.10. Among the genotypes, Prateek produced the maximum seed yield of 5.43 q ha-1, which was significantly superior to rest of the genotypes. The lowest seed yield (3.97 q ha-1) was observed with genotype Local. The seed yield is the resultant of growth and yield attributing characters of a crop. The superiority of growth characters *viz*. number of nodules and weight, branches, dry matter accumulation and yield attributes i.e pods 34 plant-1 and seeds pod-1 as discussed earlier could be accounted for the production of higher yield under genotype Prateek. The results are in accordance with the findings of Soomrao and Khan (2003) [30] and Singh and Sekhon (2007) [21, 26, 27]. Genetic differences for seed yield have also been reported by Goswami *et al.* (1998) [7]. As regards to seed rates significantly maximum seed yield was observed under the seed rate of 75 kg ha-1 as compare to seed rate of 60 kg ha-1. Higher seed yield in 75 kg ha-1 might be due to optimum plant population. Similar findings have also been reported by Soomrao and Khan (2003) [30] and Singh and Sekhon (2007) [21, 26, 27]. Singh *et al.* (2010) [28] studied the genetics of the seed yield of *Lathyrus sativus*. The differences in seed yield of lathyrus due to interaction of genotypes and seed rates were found non significant.

14. Stover yield (kg ha-1)

Data related to stover yield are presented in table 4.10. Among the genotypes, prateek produced the maximum stover yield of 702.50 kg ha-1, which was significantly superior to rest of the other genotypes. The lowest stover yield was noted with genotype Local. The higher values of growth characterstics *viz*. plant height, braches and dry matter accumulation of Prateek gave higher stover yield under this genotype. Similar results have also been reported by Kashyap *et al.* (1991) [11] where they observed a wide range of variability for number of seeds, number of pods, plant height, days to maturity and seed yield in grasspea. Shrivastava (1996) [31] reported presence of sufficient genetic variability for seed yield, seeds, pods, and branches per plant in *Lathyrus sativus*. As regards to seed rate, significantly maximum stover yield was observed under the seed rate of 75 kg ha-1 as compared to seed rate of 60 kg ha-1 obviously due to higher plant population. Similar findings have also been reported by Sharma *et al.* (1989) [24] and Singh *et al*. (2007) [21, 26, 27]. The differences in stover yield of lathyrus due to interaction of genotypes and seed rates were found non significant.

15. Harvest index (%)

The data on harvest index are presented in table 4.10. Non significant variations are observed in harvest index due to different genotypes and seed rates. Interaction effects were also noted to be non-significant for different genotypes and seed rates.

Nutrients uptake by lathyrus

Data related with nutrient uptake of N, P and K in grain, stover and total uptake are presented in table 4.13. Significantly maximum nitrogen uptake in grain and stover as well as total was recorded with genotype prateek as compared to other genotypes. However, it was comparable with genotype Ratan in case of N uptake in grain. Among seed rate, 75 kg ha-1 recorded significantly higher uptake of nitrogen in grain and stover as well as in total over 60 kg ha-1 seed rate. Phosphorus uptake in grain, stover and in total were observed significant due to different genotypes and seed rate.

Genotype, prateek recorded more uptake of phosphorus in grain, stover and in total as compared with other genotypes. However, it was at par with genotype Ratan in case of phosphorus uptake in stover. Significantly higher uptake of phosphorus in grain and in total was recorded under the seed rate of 75 kg ha-1. However there were non significant differences in uptake of phosphorus in stover due to different seed rates. Uptake of potassium was revealed significantly higher under genotypes prateek in grain, stover and in total over other genotypes. While in case of seed rate, 75 kg ha-1 recorded significantly more uptake of potassium in grain, stover and in total as compared to seed rate 60 kg ha-1. Interaction effects were noted to be non-significant for different genotypes and seed rates. Similar findings have been reported by Montenegrol and Meral (2009) [15].

ODAP content (%)

Data related to ODAP (β-N-oxalyl-L-α,β-diaminopropionic acid) content after harvest of crop in grain was analyzed and presented in table 4.14. Lathyrus is important pulse crop containing neurotoxic acid i.e. ODAP which is harmful for human and cattle consumption. From analyzed data ODAP content was significantly more under genotype Ratan as compared to other genotypes. Prateek and Mahateora resulted in low ODAP content. Sethi *et al.* (1981) [23] reported significant positive association of ODAP content with seed size and negative with seed yield. Vedna Kumari *et al.* (1995) [34] estimated heritability in broad sense for twelve quantitative characters in high and low ODAP groups of *Lathyrus sativus* genotypes. It was high for period from flowering to maturity. Non significant variations are observed in ODAP content due to different seed rates. Interaction effects were also noted to be non-significant for different genotypes and seed rates.

4.4 Bulk density (g/cc)

Bulk density of soil at initial before sowing of crop was recorded and the data are presented in table 4.14. Results revealed that, bulk density of different genotypes and seed rate treated plots were shown non significant result.

Soil moisture (%)

Soil moisture (%) status at was recorded at 15, 30, 45, 60, 75, 90 DAS and at harvest at three depth levels viz. 0-15, 15-30 and 30-45 cm and there data are presented in Table 4.15 and 4.16. and depicted in figure 4.1 to 4.8. Maximum moisture content was recorded at initial stage at three depth levels viz. 0-15, 15-30 and 30-45 cm on an average 45% and it reduced at later stages. At 15, 30, 45, 60, 75, 90 DAS and at harvest soil moisture (%) status was not significantly influenced by different genotypes and seed rates at different depth of soil profile except at harvest on depth 0-15 cm and 30-45 cm under different seed rate. At harvest, 60 kg ha-1 seed rate stored more residual soil moisture (%) content at 0-15 cm and 30-45 cm over 75 kg ha-1 The residual soil moisture (%) after rice harvest was important in relay cropping system, it helped low cost input for production of lathyrus and returned more due to low input. Most of water used in rice cultivation through bunding cultivation practices and it can be literally stored in field Ragar *et al*. (2007) [20]. Meena *et al*., (2002) [13] reported significant effect of bunding on water use efficiency of rainfed pulses. Ali and Mishra (2002) [2] also reported that lowland rice follows provide moisture and nutrient can favorably be exploited for successful cultivation of *rabi* pulses with appropriate manipulation in the selection of improved varieties of rice as well as succeeding pulse crop. Crops like mustard, castor, linseed, safflower, blackgram, lentil, lathyrus etc. can be grown by taking advantage of residual soil moisture. The second crop should shown as early as possible or in relay cropping after the harvest of rice to get the advantage of residual soil moisture. Rao *et al*. (2007) [21] reported that the task is quite challenging and the options available are very limited in view of plateauing trend of yield in high productivity areas, decreasing and degrading land, water, labour and other inputs. So, in rice crop based system after rice harvest, the available soil moisture and nutrient would be used for short growing, less water and nutrient requirement crops like lentil, mustard, lathyrus etc. are beneficial for farmer.

Correlation of soil moisture status with grain yield

Correlation coefficient was calculated for soil moisture status of 0-15 cm, 15-30 cm and 30-45 cm depth of soil with grain yield and data are presented in Appendix- III. 39 At 15 DAS, 30 DAS and 45 DAS, the grain yield exhibited positively significant correlation with soil moisture at 0-15 cm, followed by 0-30 cm and 30-45 cm depth of soil. At 60 DAS grain yield exhibited positively significant correlation with soil moisture in soil depth 30-45 cm. At 75 DAS grain yield exhibited negatively significant correlation with soil moisture in depth of soil 0-15 cm. At 90 DAS, grain yield exhibited positively significant

Conclusions

The findings of the present study in the light of experimental objectives are concluded as under: The lathyrus genotype Prateek was found superior over Ratan, Mahateora and Local genotypes in respect of growth characters; yields attributes and yield under rainfed rice-utera system. Sowing of lathyrus with 75 kg ha-1 seed rate recorded higher seed and stover yield than 60 kg ha-1 seed rate under rainfed rice-utera condition. The lathyrus genotypes Prateek gave maximum economic returns. Among the seed rates, 75 kg ha-1 recorded more economic returns than seed rate of 60 kg ha-1. Correlation with soil moisture in depth of soil 30-45 cm.

Table 1: Influence of different genotype and cutting height of rice stubble on plant height, number of branches, and dry matter accumulation.

	Plant height (cm)				**Number of branches plant^{-1}**				**Dry matter accumulation plant^{-1} (g)**			
Treatments	25 DAS	50 DAS	75 DAS	At harvest	25 DAS	50 DAS	75 DAS	At harvest	25 DAS	50 DAS	75 DAS	At harvest
Prateek	28.73	37.88	44.63	47.07	2.38	3.47	4.08	4.00	0.13	0.51	1.48	3.07
Ratan	30.42	41.17	50.10	52.15	2.42	3.90	4.53	4.48	0.14	0.63	1.76	3.75
Mahateora	28.02	37.43	43.67	46.10	2.30	3.40	4.03	3.97	0.12	0.49	1.37	3.03
Local	27.08	36.13	42.97	44.22	2.23	3.15	3.93	3.87	0.12	0.42	1.05	2.68
SEm±	0.78	1.13	1.68	1.39	0.09	0.12	0.14	0.11	0.01	0.03	0.09	0.49
CD (P=0.05)	NS	3.44	5.10	4.22	NS	0.39	0.42	0.36	NS	0.11	0.29	0.16
Farmer practice (15cm cutting height)	28.46	36.81	42.68	44.73	2.37	3.64	3.99	3.93	0.12	0.46	1.09	2.05
Improved practices (30cm cutting height)	28.67	39.50	48.01	50.03	2.30	3.32	4.29	4.18	0.14	0.54	1.73	2.72
SEm±	0.55	0.80	1.19	0.98	0.06	0.09	0.09	0.08	0.008	0.02	0.06	0.11
CD (P=0.05)	NS	2.43	3.61	2.98	NS	0.27	0.30	0.25	NS	0.07	0.20	0.34
Interaction	NS	1.04	2.15	1.15	NS	0.01	0.09	0.02	NS	0.001	0.08	0.014

Table 2: Influence of different genotype and cutting height of rice stubble on number of nodules, Dry weight of nodules, and dry matter accumulation plant-^{1}.

	Number of nodules plant-1			**Dry weight of nodules plant-^{1} (mg)**			**Root length (cm)**		**Root volume (cc)**		**Dry weight of root (g)**	
Treatments	25 DAS	50 DAS	75 DAS	25 DAS	50 DAS	75 DAS	At flowering	At harvesting	At flowering	At harvesting	At flowering	At harvesting
Prateek	7.18	12.04	8.41	11.50	37.67	22.23	8.85	9.73	0.57	0.44	0.08	0.06
Ratan	7.90	14.02	9.52	12.17	45.17	26.67	9.48	10.85	0.66	0.51	0.10	0.08
Mahateora	7.62	12.32	8.52	11.83	38.00	23.00	8.92	10.02	0.60	0.46	0.08	0.06
Local	7.15	10.42	7.50	11.33	32.33	19.00	8.25	9.13	0.49	0.39	0.06	0.05
SEm±	0.24	0.51	0.23	0.79	1.70	1.05	0.25	0.29	0.01	0.01	0.007	0.004
CD (P=0.05)	NS	1.56	0.70	NS	5.15	3.20	0.78	0.87	0.05	0.04	0.022	0.012
Farmer practice (15cm cutting height)	7.21	11.64	7.54	11.50	36.42	21.50	8.58	9.61	0.53	0.43	0.06	0.05
Improved practices (30cm cutting height)	7.72	12.75	9.43	11.92	40.17	24.00	9.17	10.26	0.62	0.48	0.10	0.07
SEm±	0.17	0.36	0.16	0.56	1.20	0.74	0.18	0.20	0.01	0.01	0.005	0.003
CD (P=0.05)	NS	1.10	0.49	NS	3.64	2.26	0.55	0.62	0.03	0.03	0.016	0.008
Interaction	NS	NS	NS	NS	2.41	2.09	NS	NS	NS	NS	NS	NS

Table 3: Influence of different genotype and cutting height of rice stubble on yield and attributes characters

Treatments	Number of pods plant^{-1}	Number of grains pod $^{-}$	Number of grains ^{1}plant^{-1}	Test weight (g)	Seed yield (q ha^{-1})	Stover yield (q ha^{-1})	Harvest Index (%)
Prateek	15.22	2.81	41.90	6.48	4.74	6.18	43.33
Ratan	16.98	3.13	53.48	6.58	5.43	7.02	43.53
Mahateora	14.57	2.73	39.92	6.30	4.69	6.15	43.29
Local	13.35	2.46	32.77	5.65	3.97	5.21	40.24
SEm±	0.63	0.08	2.53	0.03	0.19	0.26	0.84
CD (P=0.05)	1.93	0.25	7.68	1.41	0.58	0.79	NS
Farmer practice (15cm cutting height)	14.10	2.66	37.28	6.23	4.20	5.65	42.69
Improved practices (30cm cutting height)	15.96	2.90	46.76	6.26	5.21	6.63	44.01
SEm±	0.44	0.05	1.79	0.02	0.13	0.18	0.59
CD (P=0.05)	1.34	0.17	5.43	NS	0.41	0.56	NS
Interaction	NS	NS	NS	NS	NS	NS	NS

Table 4: Influence of different genotype and cutting height of rice stubble on nutrient uptake, bulk density and ODAP content

	Nitrogen uptake (kg ha-1)			Phosphorus uptake (kg ha-1)			Potassium uptake (kg ha-1)			Bulk density (g/cc)	ODAP Content (%)
Treatments	Grain	Stover	Total	Grain	Stover	Total	Grain	Stover	Total		
Prateek	9.11	5.26	14.37	2.03	1.07	3.11	5.48	22.49	27.97	1.36	0.155
Ratan	10.51	7.00	17.51	2.47	1.33	3.80	6.84	26.52	33.36	1.35	0.072
Mahateora	8.70	5.14	13.84	1.95	1.00	2.95	5.22	21.83	27.04	1.36	0.077
Local	7.12	4.28	11.39	1.46	0.72	2.18	4.16	17.81	21.98	1.38	0.097
SEm±	0.51	0.30	0.67	0.12	0.09	0.17	0.42	0.95	1.29	0.03	0.003
CD (P=0.05)	1.55	0.91	2.04	0.38	0.27	0.53	1.28	2.88	3.92	NS	0.009
Farmer practice (15cm cutting height)	9.95	5.89	15.83	2.20	1.12	3.31	6.18	24.17	30.35	1.39	0.099
Improved practices (30cm cutting height)	7.77	4.95	12.72	1.76	0.94	2.70	4.67	20.16	24.83	1.34	0.101
SEm±	0.36	0.21	0.47	0.09	0.06	0.12	0.29	0.67	0.91	0.02	0.002
CD (P=0.05)	1.10	0.64	1.44	0.27	NS	0.37	0.90	2.03	2.77	NS	NS
Interaction	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

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