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DP Singh
Senior Scientist and Head,
Krishi Vigyan Kendra,
ANDUAT, Basuli, Maharajganj,
Uttar Pradesh, India

V Chandra
Associate Professor/SMS (AS),
Krishi Vigyan Kendra,
ANDUAT, Basuli, Maharajganj,
Uttar Pradesh, India

T Tiwari
Programme Assistant,
Krishi Vigyan Kendra,
ANDUAT, Basuli, Maharajganj,
Uttar Pradesh, India

Corresponding Author:
DP Singh
Senior Scientist and Head,
Krishi Vigyan Kendra,
ANDUAT, Basuli, Maharajganj,
Uttar Pradesh, India

Compatibility of sulfosulfuron and metsulfuron-methyl for the control of complex weed *Phalaris minor* in wheat through frontline demonstrations of eastern Uttar Pradesh

DP Singh, V Chandra and T Tiwari

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Abstract
Front Line Demonstration is one of the most powerful tools for transfer of technology. The present study was undertaken to find out the yield gap through FLDs on wheat crop. Krishi Vigyan Kendra, Maharajganj, Eastern U.P. conducted 75 front line demonstration on wheat crop at farmers field of fifteen adopted villages during 2018-19 and 2019-20 for transfer of technology. In two consecutive year demonstration programme of improved wheat production technology on wheat variety HD 2967 demonstrate production potential and economic benefit of improved technologies consisting herbicidal management. Application of Sulfosulfuron + Metsulfuron 32 g/ha resulted in significantly lower plant population of *Phalaris minor* followed by effect of Isoproturon + 2,4-D (1000 + 500 g/ha) application resulted in more number of *P. minor*. Grain yield were significantly higher in treated plots as compared to the control Sulfosulfuron + Metsulfuron 32 g/ha gave maximum grain yield 36.05q/ha compared to control 22.85q/ha, which could possibly use for herbicides control in wheat crop with a considerable higher yield. The extension gap and technology gap were observed to be 13.20 q/ha, 13.95 q/ha respectively. The technology index (%) of 27.90%. Technology index was recorded to be decreased over the successive years of study the successive decreased value of technology index reflected the feasibility of the demonstrated technology in agro - climatic condition of eastern Uttar Pradesh.

Keywords: Herbicides, technology index, technology gap, BC ratio, extension gap, grain yield

Introduction

Wheat (*Triticum aestivum* L.) is the second most important cereal crop of India and plays a vital role in food and nutritional security of the country. Nearly 55 per cent of the world population depends on wheat for about 20 per cent of calories intake. It is one of the major food grains of the country and a staple food of the people of North India, where people have preference for chapatti. The diverse environmental conditions and food habits of people in India supports the cultivation of three types of wheat (bread, durum and dicoccum). Among these, bread wheat is contributing approximately 95 per cent to total production while another 04 per cent comes from durum wheat and close to one per cent from Dicoccum. In India, wheat cultivated on 29.6 m ha area with 93.5 m tonnes of production and 31.5 q/ha of average productivity (FAO, 2013) [8]. In Uttar Pradesh, it is grown on 9.73 m ha area with production 30.3 m tons and productivity of 31.14 q/ ha (Anonymous, 2013) [1]. The requirement of wheat will be around 109 million tonnes for feeding the 1.25 billion populations by 2020 AD (Singh, 2010) [10-12]. Wheat is the world's most widely cultivated food crop. Average yield losses due to weeds are 20-30%, however, heavy infestation of the formidable weeds can inflict huge crop losses (Singh *et al*. 1999) [10-12]. Grassy weeds like *Phalaris minor* and *Avena ludoviaciana* are dominant in rice-wheat rotation in North West plain zone. Continuous use of a particular herbicide may develop resistance in weeds. Herbicide mixtures may be an alternative for management or delay of cross resistance development against these herbicides (Dhawan *et al*. 2009) [7]. Keeping in view the above facts, the present investigation was undertaken to test the performance of herbicides alone or in combination to control weeds in wheat. Sulfosulfuron has been reported to provide effective control of isoproturon resistant

Phalaris minor along with marginal control of broadleaf weeds in wheat (Yadav and Malik, 2005) [2, 15]. The combinations of 2, 4-D and metsulfuron with clodinafop, fenoxaprop and sulfosulfuron were found incompatible as tank mixture (Banga and Yadav, 2004; Singh and Singh, 2005) [2, 10-12, 15]. However, sequential applications of these herbicides were found suitable for the control of broad spectrum weeds. But some of the problematic weeds like *Malwa parviflora* L. and *Convolvulus arvensis* L. have started emerging in wheat fields which are not effectively controlled either by metsulfuron or 2,4-D. Carfentrazone-ethyl has already been reported very effective against most of the broadleaf weeds including these problematic weeds (Cauchy, 2000; Singh *et al*., 2004; Walia and Singh, 2006) [3, 10-12, 13].
Providing effective extension service is inevitable to break the existing resistance by awareness creation through demonstration at farmers training centre. Complementary wheat technologies including tillage frequency, seed treatment, sowing techniques, genetically improve seed, disease, insect and weed management practice have to be provided to boost wheat production and to be change the livelihood of Indian farmers. However, most of the frontline demonstrations results have been presented in the form of yield and economic advantages and hence, quantification of yield gap minimized because of the demonstrations becomes an important area of investigation.

Materials and Methods

The present study was carried out by Krishi Vigyan Kendra Basuli, Maharajganj, Achrya Narendra Dev University of Agriculture and Technology, Kumarganj, Ayodhya for two consecutive years from 2018-19 and 2019-20 of the farmers field in five blocks *viz*. Nichlaul, Siswa Bazar, Ghughli and Laxmipur of Maharajganj district through front line demonstration. To evaluate the compatibility of sulfosulfuron @ 45g/ha and Metsulfuron-methyl and 2, 4-D @ 32+500 g/ha against complex weed flora in wheat. Front Line Demonstration is one such powerful tool for transfer of technology which practically exhibits the strength of new technologies in increasing yield and profit. Total 75 demonstrations were conducted in different village's *viz*. Blaihhore, Bhujanli, Khutamaida and Idupmmathiya 75 farmer's on 30.0 ha lands. Each frontline demonstration was laid out on 0.4 ha area while adjacent 0.4 ha was considered as control for comparison (farmer's practice). The knowledge level of the farmers in these villages was also evaluated by random sample of 20 farmers each village. Thereby sample included 400 numbers of farmers in the study. The farmers were asked to reply questions about the improved agro techniques including the high yielding varieties of wheat. The score so obtained under various questions were summed up. On the basis of the total score obtained, respondents were categorized on to three classes' i.e. low, medium and high level of knowledge. The soils of FLDs field were found sandy loam. Amendments for soil surface crusting: To tide over the soil surface crusting apply lime at the rate of 2t /ha along with FYM at 12.5 t/ha. Treat the seeds with Carbendazim or Thiram @ 2 g/kg of seed 24 hours before sowing (or) with talc formulation of Trichoderma viride @ 4g/kg of seed (or) Pseudomonas fluorescens @ 10 g/kg seed. Combined effect of sulsufuron + metsulfuron. Isoproturon + 2,4-D (1000 + 500 g/ha) application resulted in more number of P. minor plant as compared to other mixed herbicides application which might be due to resistance of *P. minor* to isoproturon. Initially up to 30 DAS, no significant difference in population of *P. minor* was recorded because no herbicide treatments were imposed in different plots of the experiment. The experimental plots were dominated mainly by *P. minor* Retz. Coronopus didymus Sw., *Anagallis arvensis* L., Melilotus indica All. Fl. Ped., *Medicago denticulata* L., *Rumex dentatus* L., *Vicia sativa* L. and *Lathyrus aphaca* L. were the major broad-leaved weeds. Recommended dose of fertilizer 120:60:40:25 NPKZnSo4 kg/ha was applied in all the demonstrations. To manage the assessed problems seeds of wheat variety HD 2967, fertilizer and plant protection chemicals were provided to the farmers as critical inputs and scientific recommended technologies were followed as intervention during the course of front line demonstration programme. The wheat crop was sown at 22.5 cm (row-row) apart in line using seed rate of 100 kg/ha in 2nd week of November during both the years. Crop was harvested on the same time of harvesting of demonstration plots. Before conduct the demonstration training to farmers of respective village was imparted with respect to envisaged technological interventions. All other steps like site selection, farmers selection, layout of demonstration, farmers participation etc. were followed as suggested by (Choudhary 1999) [4]. The data on seed yield, cost of cultivation and gross and net monetary return were collected from technological demonstration plot. In addition to this, data on farmer practices were also collected from the equal area. The benefit cost (B:C) ratio was calculated based on gross return. The following formulae were used to calculate the parameters as suggested by (Das *et al*. 1998) [5]:

1. Increase in grain Yield = Grain yield from Demo plot – Grain yield from FP plot/Grain yield from Demo plot X 100
2. Net Return = Gross Return – Cost of cultivation
3. Benefit/Cost Ratio = Gross Return/Cost of Cultivation X 100

The responses were recorded and converted in to mean percent score and ranked accordingly as per (Warde *et al*. 1991) [14]. From front line demonstration plots and farmers practice plot (control plot) and finally extension gap, technology gap, and technology index were calculated as given as formula suggested by (Samui *et al*. 2000 and Dayanand *et al*. 2012) [6] as given below.

1. Technology gap = Potential yield – Demonstration yield
2. Extension gap = Demonstration yield – farmers yield
3. Technology index = [(Potential yield – Demonstration yield) /Potential yield] x 100

The distribution of beneficiaries according to their change of area after conducting the FLD on their field. Unfortunately use of local varieties and poor nutrient management results in very low yield.

Results and Discussion

Weeds were major constraints in wheat production total weed density

All treatments significantly affected total weed density as compared with control (Table 1). Herbicide sulfosulfuron + metsulfuron 32 g/ha excelled in reducing total weed density (90.20%) followed by 73.27% as compared to control.

Total weed dry weight (g/m2)

A significant difference among treatments was also observed for weed dry weight suppression as compared with control (Table 1). sulfosulfuron + metsulfuron 32 g/ha resulted in the highest reduction in weed biomass (87.73%) over control.

Other treatments Isoproturon + 2,4-D (1000 + 500 g/ha) were statistically at par and comparable to one other in weed biomass 73.39%.

Constraints in wheat production

On perusal of data presented table -2 it was found that major constraints in wheat production were non availability of the quality seed of high yielding varieties (88.00%) was given the top most rank followed by low technical knowledge (70.67%), weed infestation (65.33%), Use of higher seed rate (58.67%), low fertility status (70.67%) and damage of crop by the wild animals (44.00%),

Yield

The data on wheat yield (Table 4 and Figure 2) indicated that the frontline demonstration had given a good impact on the farming community of Maharajganj district as they were motivated by the new agricultural technologies adopted in the demonstrations. Frontline technology gave mean wheat yield of 36.05 q/ha which was higher by 57.86% over the prevailing farmers practice (22.85 q/ ha). The results are in close conformity with the (Sharma *et al*. 2016).

Extension gap, technology gap and technology index

The technology gap observed may be attributed to dissimilarity in the soil fertility status and weather conditions. Hence location specific recommendation appears to be necessary to bridge the gap between the yields. The highest extension gap of 13.40 was recorded during 2018-19 which emphasized the need to educate the farmers through various means for the adoption of improved high yielding varieties and newly improved agricultural technologies to reverse this trend of wide extension gap. More and more use of new HYV's by the farmers will subsequently change this alarming trend of galloping extension gap (Hedge, 2004). This high extension gap in all these varieties requires urgent attention from planners, scientists, extension personnel and development departments. The lower the value of technology index more is the feasibility of the technology, the new technologies. Will eventually lead to the farmers to discontinuance of old varieties with the new technology, the technology index shows the feasibility of the evolved technology at the farmers' field. The technology index is 29.00 and 26.80 percent during two years study, respectively which shows the good performance of wheat in Maharajganj conditions and this will accelerate the adoption of. Newer technologies to increase the productivity of sesame in this area. These results are in conformity with the findings of (Sagar and Ganesh Chandra 2004) [9].

Economics

The economic viability of improved demonstrated technology over farmers practice was calculated depending on prevailing price of inputs and outputs cost and represented in the term of B:C ratio (Table 5 & Figure 3). It was found that the cost of production of wheat under demonstration with an average Rs.30644 under control. The additional cost increased in demonstration was mainly due to more cost involved in balanced fertilizer, procurement of improved seed and management of weeds. The cultivation of wheat under improved technologies gave average net return of Rs. 67,864/ha which was lower Rs. 43,015/- in farmer's practices. The benefit cost ratio of wheat with an average of 2.21 in demonstration plots and 1.88 farmers practice. This may be due to higher yield obtained and lower cost of cultivation under improved technologies compared to farmers practice.

There is a need to adopt multipronged strategy which involves enhancing wheat production through horizontal and vertical expansion and productivity improvements through better adoption of improved technology. In the fragile environments and poor farm resource base, wheat is the best choice for farmers.

Table 1: Effect of various weedicides and hand weeding on total weed density and weed dry weight in wheat

Treatments	Total weed density/m		Mean	% decrease over control	Total weed dry weight (g/m2)		Mean	% decrease over control
	2018	2019			2018	2019		
T1-Sulfosulfuron + Metsulfuron 32 g/ha	5.40	6.60	6.00	90.20	6.11	7.56	6.84	87.73
T2-Isoproturon + 2,4-D (1000 + 500 g/ha)	15.43	17.33	16.38	73.27	13.96	15.69	14.83	73.39
T3-Hand hoeing (two)	16.60	19.90	18.25	70.21	14.40	16.90	15.65	71.92
T4-Control farmers practice	60.63	61.92	61.28	—	54.90	56.60	55.75	—

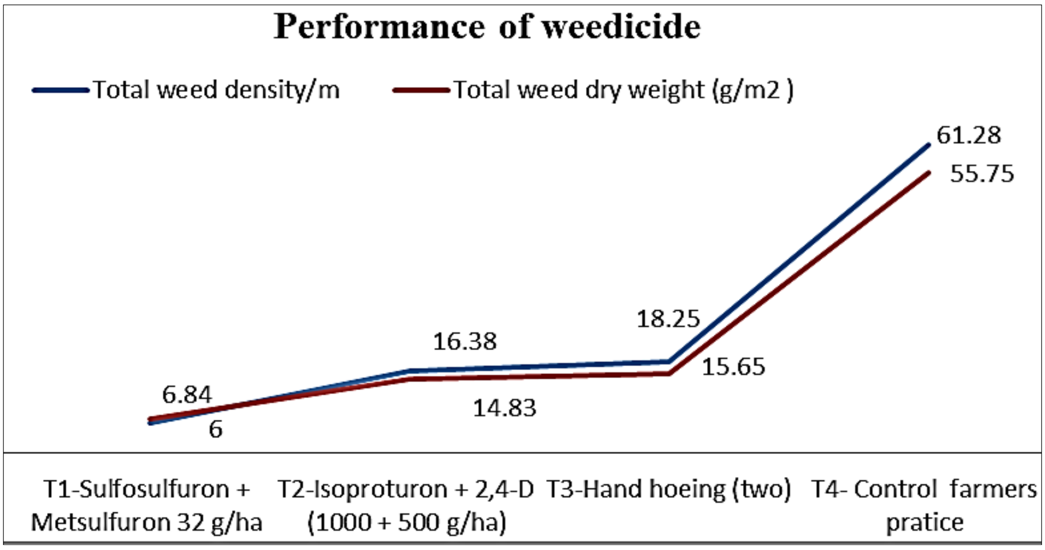

Fig 1: Effect of various weedicides of wheat

Table 2: Ranks for different constraints (f = 75) given by farmers

S. No.	Constraints	Farmers	Percentage	Rank
1	Non availability of the seeds of high yielding varieties	66	88.00	I
2	Low technical knowledge	53	70.67	II
3	Use of higher seed rate	44	58.67	IV
4	Low soil fertility	41	54.67	V
5	Weed infestation	49	65.33	III
6	Damage by bull	33	44.00	VI

Table 3: Cost of cultivation of wheat

Cost of cultivation	Demo	FP
Harrowing	8000	8000
Plowing	4000	4000
Seed Dril	4000	—
Fertilizer NPK 120:60:40 (Farmers Practice 150:40)	6088	4188
Seed treatment	1000	—
Weedicides	1000	—
Irrigation	1100	1100
Harvesting	5000	5000
Total Rs.	30188	22288

Table 4: Performance of front line demonstrations (FLD) of wheat

			Potential grain yield (q/ha)	Grain yield (q/ha)		% increase over FP	Extension gap (q/ha)	Technology gap (q/ha)	Technology index
Year	No. of demo	Area (Ha)		Demo	FP				
2018-19	36	15	50	35.50	22.10	60.63	13.40	14.50	29.00
2019-20	39	15	50	36.60	23.60	55.08	13.00	13.40	26.80
Average	37.5	15	50	36.05	22.85	57.86	13.20	13.95	27.90
Total	20	30	—	—	—	—	—	—	—

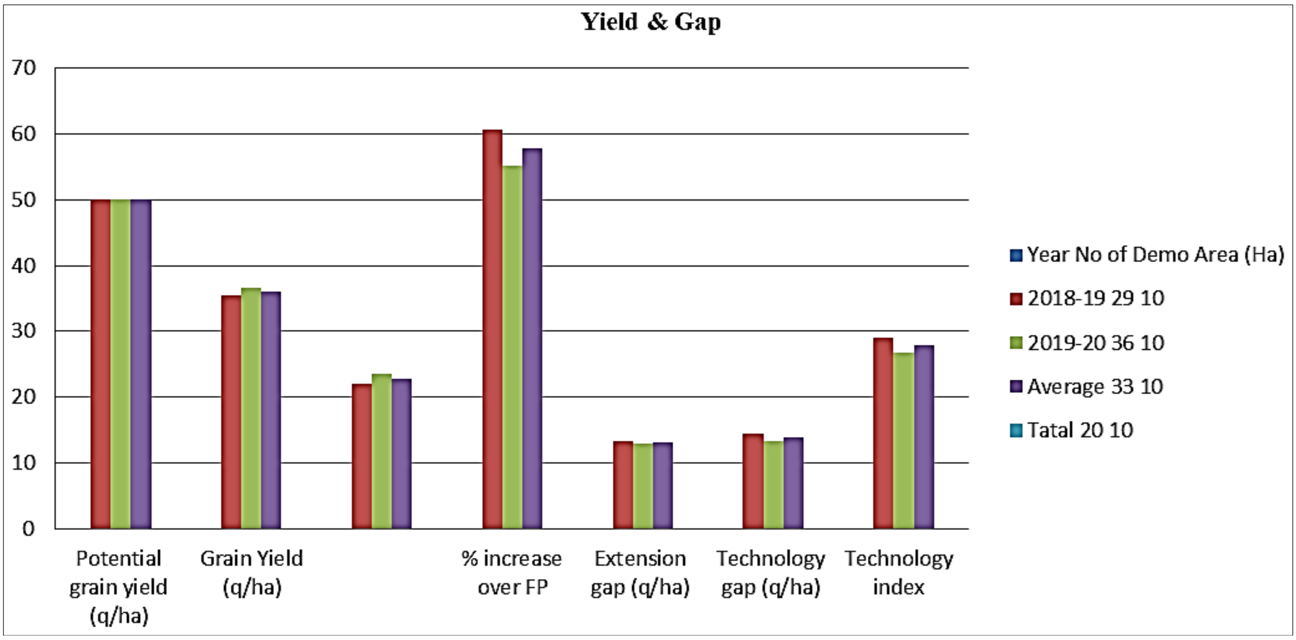

Fig 2: Grain yield and gap of FLD of wheat

Table 5: Seed yield and economics of wheat as affected by improved and local practices in farmers' fields

Year	Potential grain yield (q/ha)	Cost of cash input		Additional cost in demonstrations (Rs./ha)	Sale price of grain (MSP) (Rs./qt)	Grain yield (q/ha)		Total returns Rs. (ha		Extra returns	Incremental benefit: Cost ratio	
		Demo	FP			Demo	FP	Demo	FP		Demo	FP
2018-19	50	30188	22288	7900	1840	35.50	22.10	65320	40664	35132	2.16	1.82
2019-20	50	31100	23400	7700	1925	36.60	23.60	70455	45430	39355	2.27	1.94
Average	50	30644	22844	7800	1883	36.05	22.85	67864	43015	37220	2.21	1.88

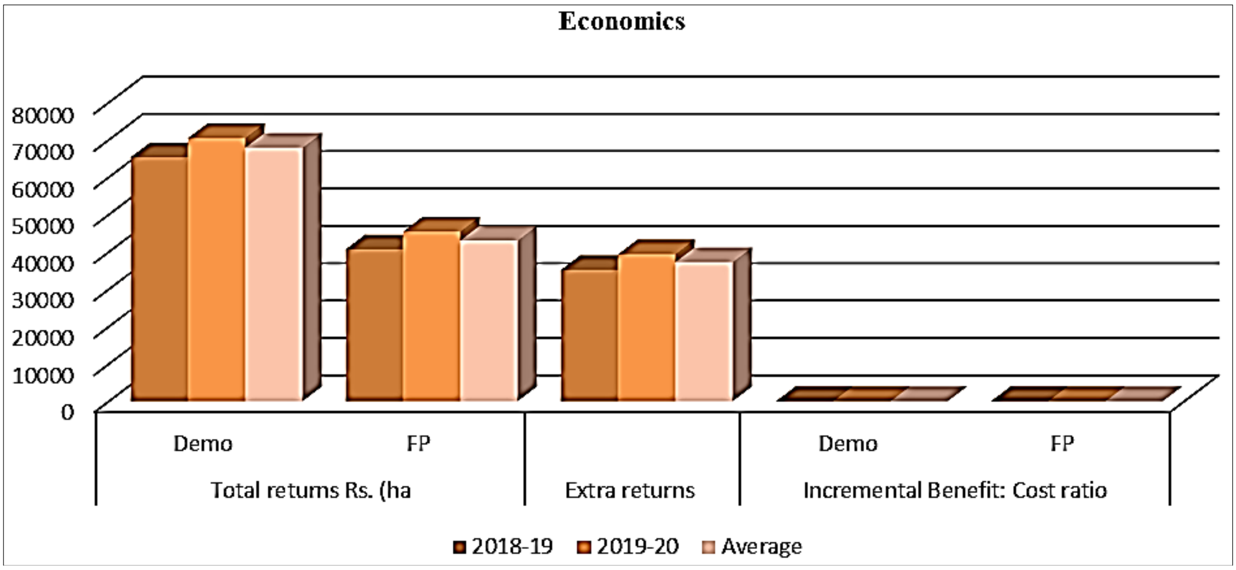

Fig 3: Economics of wheat as affected by improved and local practices in farmers' fields

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