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Response of wheat for NPK foliar sprays under water stress condition

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Abstract
Wheat is the important cereal crop of India which is grown under flood irrigation with traditional nutrient management. In this context a field experiment to study the response of NPK foliar sprays on yield and quality of wheat under water stress condition especially for newly released wheat variety NIAW 1415 (*Netravati*) was carried out at Agricultural Research Station, Niphad, Dist. Nashik, Maharashtra. The main treatments were comprised of different irrigation levels i.e. one irrigation at 40-42 days after sowing (DAS), two irrigations at 20-22 and 60-65 DAS and three irrigations at 20-22, 40-42 and 60-65 DAS. The sub treatments were absolute control, general recommended dose of fertilizer (GRDF), GRDF+ 3 water sprays, 75 % of GRDF+ 3 NPK foliar sprays (19:19:19 N:P_2O_5:K_2O) and 100 % of GRDF + 3 NPK sprays. The results of two years experimentation revealed that, irrigating the wheat variety NIAW 1415 with three irrigations at 20-22, 40-42 and 60-65 DAS along with 100 % of GRDF + 3 NPK sprays produced significantly higher grain (45.11 q ha^{-1}) and straw (68.67 q ha^{-1}) yields over rest of the treatments. Nutritional status of the soil was also improved due to different nutrient treatments over initial status.

Keywords: Wheat, NIAW 1415, irrigation, GRDF and foliar sprays

Introduction
Wheat is the most important cereal crop of the world and India. In Maharashtra it occupies second position next to sorghum. It is cultivated on an area of about 6.29 lakh ha with the total production of 7.58 lakh metric tons having the average productivity of 1205 kg/ha as against the national productivity of 3093 kg/ha (Anonymous, 2016) [1].

Among major abiotic stresses, drought stress is one of the factor that drastically affect crop production around the globe (Shahbaz *et al*., 2011) [8]. Exposure to drought stress poses serious challenges for the survival of plants, because it results in impaired germination and seedling growth (Ashraf *et al*., 2006) [3] and affects plant growth (Xu *et al*., 2007) [12], and reduced harvestable yield of plants (Nawaz *et al*., 2012) [11].

Foliar application gives guarantee for the availability of nutrients to crops for obtaining higher yield. (Arif *et al*, 2006) [2]. Among major nutrients, nitrogen plays a vital role in increasing the yield of crop. Application of proper amount of nitrogen is considered key to obtain bumper crop of wheat. Foliar application of nitrogen has more effect on yield and yield components of wheat because it is more effective as minimum losses involved in foliar spray. (Sud *et al*., 1990) [9].

In many agricultural production systems, phosphorus (P) has been identified as the most deficient essential nutrient after nitrogen (N). Nutrient inputs into production systems have increased as a result of the need for high yielding crops to sustain the growing population around the world. Phosphorus originates from the weathering of soil minerals and other stable soil geologic materials and exists in both inorganic and organic forms of which the inorganic fraction is dominant. (Mosali *et al*., 2006) [6].

Potassium is a “work horse” plant nutrient. Perhaps this is why it is not bound into any specific plant compound. Therefore, potassium is free to travel and to wheel and deal within the plant almost at well. It should not be surprising that a shortage of potassium can result in loss of crop yield, quality and profitability. Foliar spray of potassium in combination with nitrogen and some micro-nutrients like zinc had significant effect on grain yield of wheat (Eman and Mogied, 1998) [4].

Materials and Methods
A field experiment on wheat (cv 1994) with irrigation levels and fertilizer management

including foliar nutrient sprays was conducted at Agricultural Research Station, Niphad, Dist. Nasik (MS). The soil of the experimental site was clayey in texture having pH 8.02, EC 0.52 dSm^{-1}, medium in organic carbon (0.42 %), low in nitrogen (189 kg ha^{-1}), low in phosphorous (11.59 kg ha^{-1}) and high in potassium (458 kg ha^{-1}). The experiment was laid in split plot design with three irrigation levels (One irrigation (40-42 days after sowing), Two irrigations (20-22 and 60-65 DAS) and Three irrigations (20-22, 40-42 and 60-65 DAS) as main treatments and five fertilizer levels (Absolute control, General Recommended Dose of Fertilizer (GRDF), GRDF+ 3 Water Sprays, 75 % GRDF+ 3 NPK sprays and 100 % GRDF+ 3 NPK sprays as sub treatments and replicated three times. Three sprayings of 19:19:19 foliar grade fertilizer @ 2 per cent were given at tillering stage (40-45 days after sowing), boot stage (60-65 DAS) and grain filling stage (80-85 DAS). In *kharif* season, soybean was taken as general crop.

Results and Discussion

The data from Table 1 revealed that irrigating the wheat crop (cv NIAW 1994) at 20-22, 40-42, 60-65 DAS (A_3) produced significantly higher grain (43.84 q ha^{-1}) and straw (67.81 q ha^{-1}) yields with higher thousand grain weight (40.90 g). The wheat variety NIAW 1994 (Netravati) is released in Peninsular Zone mainly for limited irrigation condition. Regarding fertilizer application treatments, application of 100% GRDF + 3NPK sprays (B_5) produced significantly higher grain (45.11 q ha^{-1}) and straw (68.67 q ha^{-1}) yields with higher thousand grain weight (42.53 g) over rest of the treatments. However, the interaction effect was non-significant. Shabbir *et al* (2015) [7] reported that limited water supply significantly reduced germination, growth and uptake of N, P and K. Supplemental foliar fertilisation of these macronutrients alone or in different combinations significantly improved the water relations, gas exchange characteristics and nutrient contents in both the genotypes. Emam and Borjian (2000) [5] reported that wheat cultivars responded differently to the rate of foliar N feeding so that, over the growth stages, Marvdasht cultivar produced significantly greater grain yield (+19 %) by application of 8 kg N ha^{-1}, whereas, the Phalat cultivar had greater grain yield (+27 %) when it was supplied by 16 kg N ha^{-1}. Increase in grain yield was mainly due to an increase in number of grains ear^{-1}. The fertile ears m^{-2} and mean grain weight were not significantly affected by foliar urea feeding, however, the harvest index and biological yield were increased. The pre-anthesis foliar feeding with urea resulted in higher yields as compared with later applications. Also the early foliar urea feeding increased the harvest index from 42.4 to 46.9 per cent at 32 kg N ha^{-1} in Marvdasht cultivar.

Data of soil analysis after harvest of wheat (Table 2) revealed that, there were no significant changes in pH, organic carbon and available phosphorous due to different irrigation levels. The nitrogen and potassium content were influenced due to irrigation levels. Higher values of nitrogen and potassium were observed in the one irrigation treatment over rest of irrigation treatments. While in sub plot treatments, significantly higher values of nitrogen and potassium were observed due to application of recommended dose of fertilizers. Narimani *et al* (2010) [10] reported that all fertilizer treatments imposed positive effects on spike length and kernel protein content, but Zn had highest positive effect on them (13.4 % and 9.6 % compared to check, respectively). All fertilizer treatments imposed positive effects on test weight, but Cu had highest positive effect on it (6.1 % compared to check).

Table 1: Wheat grain, straw yield and thousand grain weight

Treatments	Yield (q ha^{-1})		'000' grain wt (g)
A) Irrigation levels (Main Plot)	**Grain**	**Straw**	
1. One irrigation (40-45 DAS)	33.41	51.54	38.61
2. Two irrigations (20-22, 60-65 DAS)	39.91	56.30	39.81
3. Three irrigations (20-22, 40-42 and 60-65 DAS)	43.84	67.81	40.90
SE+	1.33	2.93	0.15
CD at 5%	3.81	8.36	0.44
B) Fertilizers (Sub Plot)			
1.Control	27.88	41.48	36.00
2.GRDF	41.76	61.78	40.15
3. GRDF+ 3 Water Sprays	41.85	62.99	40.51
4. 75 % GRDF+ 3 NPK sprays	38.67	57.83	39.69
5. 100 % GRDF+ 3 NPK sprays	45.11	68.67	42.53
SE+	2.28	4.28	0.43
CD at 5%	4.72	8.89	0.91
C) Interaction A X B			
SE+	3.77	7.25	0.69
CD at 5%	NS	NS	1.46

Table 2: Soil nutrient status after harvest of wheat

Treatments	pH	EC (dSm^{-1})	OC (%)	N	P	K
				(kg ha^{-1})		
A) Irrigation levels (Main Plot)						
Initial nutrient status	8.59	0.35	0.51	158	11.40	284
1. One irrigation (40-45 DAS)	8.40	0.43	0.55	217	20.48	352
2. Two irrigations (20-22, 60-65 DAS)	8.45	0.37	0.55	213	20.46	344
3. Three irrigations (20-22, 40-42 and 60-65 DAS)	8.47	0.39	0.53	205	21.30	346
SE+	0.08	0.01	0.01	1.30	0.29	1.34
CD at 5%	NS	0.04	NS	5.22	NS	5.41
B) Fertilizers (Sub Plot)						
1.Control	8.40	0.39	0.53	179	16.83	303
2.GRDF	8.44	0.41	0.51	222	22.09	388
3. GRDF+ 3 Water Sprays	8.50	0.44	0.54	212	24.60	377
4. 75 % GRDF+ 3 NPK sprays	8.37	0.41	0.56	219	23.45	360
5. 100 % GRDF+ 3 NPK sprays	8.49	0.35	0.58	205	16.77	307
SE+	0.06	0.01	0.01	3.30	0.67	2.91
CD at 5%	NS	0.05	0.03	9.69	1.98	8.56
Interaction A X B						
SE+	0.13	0.03	0.02	5.27	1.08	4.71
CD at 5%	NS	0.09	NS	15.83	3.28	14.26

Conclusion

From the experiment conducted to study the response of NPK foliar sprays on yield and quality of wheat under water stress condition especially for newly released wheat variety NIAW 1415 (*Netravati*), it is concluded that three irrigations at 20-22, 40-42 and 60-65 DAS along with recommended dose of fertilizers (120:60:40 $N:P_2O_5:K_2O$ kg ha^{-1} + FYM @ 10 t ha^{-1}) and 3 NPK sprays of 19:19:19 foliar grade fertilizer @ 2 per cent at tillering (40-45 DAS), boot (60-65 DAS) and grain filling stage (80-85 DAS) should be given for higher yield of wheat.

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