Annals of Plant and Soil Research 15(1): 19-22 (2013)

INFLUENCE OF BALANCED NUTRITION, WEED CONTROL AND SOWING METHODS ON YIELD AND NUTRIENT UPTAKE BY DURUM WHEAT

NEERAJ HADA[1], V. NEPALIA[2] AND S.S. TOMAR[3]

Maharana Pratap University of Agriculture and Technology, Krishi Vigyan Kendra, Borkheda, Kota (Rajasthan), India

Received: June, 2012

ABSTRACT

The experiment using durum wheat (Triticum durum Desf.) was laid out in split plot design, comprising two sowing methods (normal line sowing at 23 cm and cross sowing at 23 cm x 23 cm), three weed control treatments (weedy check, 2,4-D at 500 g ha^{-1} and metsulfuron methyl at 4 g ha^{-1}at 30 DAS) in main plots and four nutrient combinations (NPK 120+40+30 kg ha^{-1}, NPK + S 50 kg ha^{-1}, NPK+Zn 5 kg ha^{-1} and NPK+S+Zn) in sub plots and was replicated thrice. Balanced nutrition (120 kg N + 40 kg P_2O_5 + 30 kg K_2O +50 kg S + 5 kg Zn ha^{-1}) significantly increased the number of effective tillers m^{-2}, grains ear^{-1}, grain weight ear^{-1}, 1000-grain weight, grain, straw and biological yields of durum wheat. The highest yield was recorded under NPK+ S + Zn fertilization which were significantly higher over rest of the nutrient combinations. Overall increase in grain yield was 14.06, 11.71 and 19.53% owing to NPK+S, NPK+Zn and NPK+S+Zn fertilization, respectively, over NPK alone. Soil enrichment with NPK+ S + Zn also accounted for significantly higher nutrient (N, P, K, S and Zn) uptake by durum wheat crop over other treatments. Weed control through 2,4-D at 500 g ha^{-1} and metsulfuron methyl at 4 g ha^{-1} post-emergence at 30 DAS significantly increased the effective tillers m^{-2}, grains ear^{-1} and grain weight ear^{-1}. Both these herbicides gave significantly higher yields and NPKS and Zn uptake by crop than the weedy check and were at par with each other. Cross sowing resulted in significantly higher yield attributes, grain, straw and biological yields and nutrient uptake than normal line sowing.

Keywords: Balanced nutrition, weed control, soeing methods, yield durum wheat

INTRODUCTION

Wheat is the second most important food-grain in terms of production after rice in India. It is expected to experience highest ever harvest of 90.23 million tonnes in 2011-12 (Anonymous, 2012). The government does not offer a separate estimate of different types of wheat through any of its crop forecasting or monitoring programmes. However, it is envisaged that almost 95% share of total wheat production is that of bread wheat (*Triticum aestivum*) whereas the share of *T. durum* is only 4%. Nevertheless, durum wheat has good export potential because not many countries are producing good quality durum. This warrants spotlight on cultivation of durum wheat in our country (Tyagi *et al.*, 2009). In view of its importance in food industry for the preparation of pastes, sweet and savory dishes, suji and bati, etc. there is need to develop appropriate agro-technologies for improving productivity of this crop. With intensification of agriculture, apart from primary nutrients, deficiency of sulphur and micronutrients is increasing thus declining soil fertility and nutrient imbalances have become major factors affecting agricultural productivity. Apart from primary nutrients, sulphur and zinc deficiencies are widespread in Indian semi-arid tropical soils (Sahrawat *et al.*, 2007). Looking to all aspects of productivity and quality, the concept of balanced nutrition need to be exploited, using all these five nutrients. Weeds cause enormous losses in production and productivity of all major crops. In India, wheat is prone to being heavily infested with weeds which can cause considerable yield reduction (Das and Yaduraju, 2012). Planting of wheat is considered to be of prime importance for proper distribution of plants over cultivated area, thereby better utilization of available soil and atmospheric resources. Manipulating plant geometry by cross sowing has conclusively proved for yield advantage of *T. aestivum* (Jat *et al.*, 2004). It needs to be exploited in durum also. Keeping the above consideration in view, the present experiment was conducted.

MATERIALS AND METHODS

A field experiment was conducted at Krishi Vigyan Kendra, Kota (Rajasthan) during rabi seasons of 2003-04 and 2004-05. The soil was clay loam in texture and slightly alkaline in reaction (pH 7.9), medium in organic carbon (7.0 kg^{-1}), available nitrogen (257 kg ha^{-1}), phosphorus (15.8 kg ha^{-1}),

1. *Rajmata Vijayaraje Scindhia Krishi Vishva Vidhyalaya, Gwalior*
2. *Maharana Pratap University of Agriculture and Technology, Udaipur*
3. *Maharana Pratap University of Agriculture and Technology, Agricultural Research Station, Kota*

high in potassium (470 kg ha^{-1}), low in sulphur (8.1 mg kg^{-1} soil) and zinc (0.71 mg kg^{-1} soil). The experiment was laid out in split plot design, comprising two sowing methods (normal line sowing at 23 cm and cross sowing at 23 cm x 23 cm), three weed control treatments (weedy check, 2,4-D at 500 g ha^{-1} and metsulfuron methyl at 4 g ha^{-1} at 30 DAS) in main plots and four nutrient combinations (NPK 120+40+30 kg ha^{-1}, NPK + S 50 kg ha^{-1}, NPK+Zn 5 kg $ha^{-1}$and NPK+S+Zn) in subplots and was replicated thrice. Nitrogen was applied through urea (after deducting the quantity of N applied through DAP), phosphorus through DAP, potassium through MOP, sulphur through mineral gypsum and zinc through Zn SO_4. Durum wheat cv. HI-8498 was sown on 25th November and 2nd December 2003 and 2004, respectively. As per treatment the total quantity of phosphorus, potassium, sulphur, zinc and half dose of nitrogen were drilled in furrows before sowing. The remaining half of nitrogen was top dressed at first irrigation applied at CRI stage. Herbicides as per treatment i.e. 2,4-D at 500 and metsulfuron methyl at 4 g ha^{-1}were applied 30 days after sowing of wheat, with the help of a knapsack sprayer fitted with flat fan nozzle with a spray volume of 600 litre/ha. The crop was grown with all recommended package of practices except the treatments under investigation. Standard methods were employed for determination of nutrient concentration in plant samples i.e. Nesseler's reagent colorimeteric method for N (Lindner, 1944), Vanadomolybdo phosphoric yellow colour method for P and flame photometer for K, turbidimetric method for S (Tabatabai and Bremner, 1970) and atomic absorption spectrophotometer for zinc.

RESULTS AND DISCUSSION

Effect of nutrient combinations

The application of either S or Zn or S+Zn in addition to NPK significantly improved the yield attributing characters, quality parameter, grain, straw and biological yields compared to NPK alone. Increase of 7.2, 5.4 and 9.0% in number of effective tillers m^{-2}, 5.8, 4.6 and 6.8% in grains ear^{-1}, 11.5, 8.8 and 12.38% in grain weight ear^{-1} and 5.1, 3.8 and 6.1% in 1000-grain weight were observed on pooled basis with NPK+S, NPK+Zn and NPK+S+Zn over NPK alone, respectively. However, maximum values of yield attributing characters were recorded with the application of NPK+S+Zn. Maximum grain, straw and biological yields were recorded with NPK+S+Zn (46.93, 57.87 and 104.80 kg ha^{-1}) which were significantly higher over rest of the nutrient combinations. Overall increases in grain yield were 14.0, 11.7 and 19.5% with application of NPK+S, NPK+Zn and NPK+S+Zn. The harvest index was also significantly influenced by these nutrient combinations over NPK alone. Combined application of sulphur and zinc with recommended NPK also resulted in higher net returns (30246 ha^{-1}).The nutrient (N, P, K, S and Zn) uptake were significantly increased by the application of NPK+S, NPK+Zn and NPK+S+Zn over NPK alone (Table 2). However, maximum nutrient uptake was recorded under NPK+S+Zn supplied plots.

Table 1: Effect of balanced nutrition, weed control and sowing methods on yield and yield attributes of durum wheat (Pooled)

Treatments	Effective tillers m^{-2}	Grains ear^{-1}	Grain wt.ear^{-1} (g)	Test weight (g)	Grain yield (q ha^{-1})	Straw yield (q ha^{-1})	Biological yield (q ha^{-1})	Harvest index (%)	Net Returns (` ha^{-1})
Fertilization									
NPK	302.30	43.20	2.26	49.88	39.26	50.71	89.97	43.61	25013
NPK + S	324.16	45.73	2.52	52.45	44.78	55.23	100.02	44.73	29750
NPK + Zn	318.77	45.18	2.46	51.79	43.86	53.49	97.35	45.02	27453
NPK + S + Zn	329.66	46.16	2.54	52.95	46.93	57.87	104.80	44.75	30246
S.Em. ±	2.36	0.37	0.03	0.57	0.42	0.54	0.76	0.29	507
C.D. (P = 0.05)	6.79	1.07	0.09	1.65	1.19	1.53	2.14	0.83	1456
Weed control									
Weedy check	302.35	43.67	2.30	51.34	40.68	51.47	92.16	44.10	25581
2,4-D	324.70	45.66	2.51	51.65	44.65	55.12	99.77	44.71	28875
Metsulfuron methyl	329.12	45.87	2.54	52.30	45.79	56.28	102.17	44.76	29891
S.Em. ±	3.84	0.41	0.03	0.88	0.59	0.95	0.90	0.36	657
C.D. (P = 0.05)	12.10	1.51	0.10	N.S.	1.69	1.72	2.66	N.S.	2072
Sowing methods									
Line sowing	306.47	43.59	2.29	51.41	41.10	52.24	93.34	44.00	26157
Cross sowing	330.98	46.55	2.60	52.12	46.32	56.41	102.73	44.05	30074
S.Em. ±	3.13	.038	0.02	0.72	0.46	0.47	0.73	0.29	536
C.D. (P = 0.05)	6.71	0.81	0.05	N.S.	1.38	1.40	2.17	N.S.	1692

Application of 50 kg S and 5 kg Zn ha^{-1} along with recommended dose of NPK resulted in enhanced uptake of N, P, K, S and Zn by 28.0, 18.5, 32.2, 37.3 and 38.1% compared to alone NPK application. Nutrient uptake by crop is mainly a concern of total biomass production and nutrient concentration in plant parts. The concentration of nutrients also increased due to balanced nutrition because of improved nutritional environment in rhizosphere and consequently in plant system. It has been well emphasized that balanced nutrition with NPK + S + Zn markedly improved overall growth of the crop by virtue of its impact on morphological and photosynthetic components along with accumulation of nutrients. This provides opportunity for availability of nutrients and metabolites for growth and development of reproductive structure (sink), which ultimately resulted in realization of higher productivity of individual plants. The results of present investigation indicating positive response of various yield parameter and yield of wheat to balanced nutrition through sulphur and zinc corroborates the findings of Brar *et al.* (2009) and Patel (2011).

Effect of weed control

Yield attributes viz., effective tillers, grains/ear and grain weight/ear was increased significantly by different weed control treatments over the weedy check (Table 1). However, 1000-grain weight remained unaffected. Increased in effective tillers m^{-2} was 7.4 and 8.8%, in grains ear^{-1} 5.8 and 6.8% and in grain weight, it was 9.1 and 10.4%, respectively under 2, 4-D and metsulfuron methyl, over the weedy check. The application of 2, 4-D and metsulfuron methyl were statistically at par in respect of yield attributes. Similar results were obtained by Singh and Singh (2005). The lowest values of yield attributing characters were obtained under weedy check which was due to the fact that wheat plants in weedy check were under competitive stress for all resources. As yield is the resultant of yield attributes, maximum values of these parameters due to less crop weed competition in metsulfuron methyl treated plots resulted in the highest grain yield (Table 1) which was at par with that of 2, 4-D. Similar trends were also observed in respect of straw and biological yield. The data indicate 9.7-12.4, 7.1-9.3 and 8.2-10.0 % increase in grain, straw and biological yields of the test crop by exercising chemical weed control. Compared to unweeded control, the herbicides tented to give 16.8 – 16.9 % more returns from the crop. The increase in yield with these herbicides was due to significant reduction in density and dry matter of weeds which consequently resulted in the better expression of yield components and thus gave higher yield of wheat. The improvement in yield with these herbicides was also reported by Agasimani et al. (2010). Harvest index was not affected by weed control treatments. The enhancement in nutrient (N, P, K, S and Zn) uptake of wheat crop was also observed in weed control treatments over the weedy check (Table 2). A perusal of uptake figures reveals that metsulfuron methyl and 2, 4-D were at par but significantly superior over weedy check. The nutrient uptake is primary governed by total biomass production and secondarily on nutrient status of plant. Improvement in both these under weed control resulted in higher uptake of nutrients. Similar findings were reported by Chopra *et al.* (2008)

Table 2: Effect of balanced fertilization, weed control and sowing methods on nutrient uptake by durum wheat (Pooled)

Treatments	N ($kg\ ha^{-1}$)	Ph ($kg\ ha^{-1}$)	K ($kg\ ha^{-1}$)	S ($kg\ ha^{-1}$)	Zn ($g\ ha^{-1}$)
Fertilization					
NPK	104.8	28.2	92.0	17.2	2185.1
NPK + S	126.8	32.4	113.3	22.0	2464.1
NPK + Zn	122.2	30.2	108.0	20.2	2765.8
NPK + S + Zn	134.2	33.4	121.7	23.6	3017.1
S.Em. ±	1.73	0.36	1.68	0.26	30.91
C.D. (P = 0.05)	4.98	1.06	4.85	0.76	88.66
Weed control					
Weedy check	109.3	28.4	99.3	18.9	2420.0
2,4-D	126.7	31.8	111.3	21.4	2672.2
Metsulfuron methyl	130.0	33.9	115.6	22.0	2731.9
S.Em. ±	2.30	0.61	1.59	0.34	36.3
C.D. (P = 0.05)	7.26	1.93	5.09	1.07	114.40
Sowing methods					
Line sowing	115.0	29.2	102.5	19.6	2477.0
Cross sowing	129.0	32.9	115.0	21.9	2739.0
S.Em. ±	1.88	0.50	1.31	0.27	30.14
C.D. (P = 0.05)	5.93	1.57	4.15	0.87	93.40

Effect of sowing methods

Cross sowing recorded maximum number of effective tillers m^{-2} (330.98), number of grains ear^{-1} (46.55) and grain weight ear^{-1} (2.60 g), which were significantly higher than normal line sowing (Table 1). However, 1000-grain weight was not affected significantly by sowing methods. Cross sowing resulted maximum grain (46.32 q ha^{-1}), straw a (56.41 q ha^{-1}) and biological yields (102.73 q ha^{-1}) which were significantly higher over normal line sowing. Additional 3017 were realized from the crop when cross sowing was done. The harvest index was also significantly increased by sowing methods over normal line sowing. Pandey and Dwivedi (2007) and Kumar and Singh (2012) also reported higher wheat yield through geometry manipulation by cross sowing. Higher yield under cross sowing was due to better crop canopy development which resulted in more efficient utilization of solar radiation and nutrients by the crop. In comparison to line sowing, cross sowing significantly increased nutrient (N, P, K, S and Zn) uptake by crop (Table 2). Nutrient uptake is outcome of total biomass and concentration of nutrients at cellular level, thus improvement in both these under cross sowing manifested in highest uptake of nutrients.

REFERENCES

Agasimani, C.A., Shanwad, U.K., Arvindkumar, B.N., Shivamurthy, S.D., Surwenshi,A. and Jalageri, B.R. (2010) Integrated weed management (IWM): A long term case study in groundnut-wheat cropping system in North Karnataka. *Research Journal of Agricultural Sciences* **1:** 196-200.

Anonymous (2012) Food-grain production in 2011-12 estimated at 252.56 million tones – Records achieved in production of wheat, rice, urad and cotton – 3rd advance estimates of crop production for 2011-12 released. Press Information Bureau, Government of India, Ministry of Agriculture, 23-April-2012

Brar, B.S., Benipal, D.S. and Singh, J. (2009) Response of wheat to different levels of phosphorus and sulphur in alluvial soils of Punjab. *Indian Journal of Ecology* **36**: 18-21

Chopra, N.K., Chopra, N. and Singh, H.P. (2008) Assessment of nutrient uptake by weeds and crop and its subsequent effect on grain quality of wheat (*Triticum aestivum*). *Indian Journal of Agricultural Sciences* **78**: 540-542.

Das, T.K. and Yaduraju, N.T. (2012) Effects of combining modified sowing methods with herbicide mixtures on weed interference in wheat crop. *International Journal of Pest Management* **58**: 311-320.

Jat, R.S., Nepalia, V., Shivran, A.C. and Mehta, J.P. (2004) Growth and yield performance of wheat (*Triticum aestivum* L.) as affected by weed control and methods of sowing. *Research on Crops* **5**:18-21.

Kumar, S. and Singh O.P. (2012) Effect of seed treatment and sowing methods on growth and economics of late sown wheat (*Triticum aestivum* L.). *Environment and Ecology* **30**:1115-1117.

Lindner, R.C. (1944) Rapid analytical methods for some of more common inorganic constituents of plant tissues. *Plant Physiology* **19**: 76-89.

Pandey, I.B. and Dwivedi, D.K. (2007) Effect of planting pattern and weed control methods on weed growth and performance of of wheat (*Triticum aestivum*). *Indian Journal of Agronomy* **52**:235-238.

Patel, K.P. (2011) Crop responses to zinc: cereal crops. *Indian Journal of Fertilizers* **7**(10):84-100.

Sahrawat, K.L., Wani, S.P., Rego, T. J., Pardhasaradhi, G. and Murthy, K.V.S. (2007) Widespread deficiencies of sulfur, boron and zinc in Indian semi-arid tropical soils: on farm crop responses. *Current Science* **93**: 1428-1432.

Singh, J. and Singh, K.P. (2005) Effect of organic manures and herbicides on yield and yield attributing characters of wheat. *Indian Journal of Agronomy* **50**:289-91.

Tabatabai, M.A. and Bremner, J.M. (1970) A simple turbidimetric method of determining total sulfur in plant materials. *Agronomy Journal* **62**: 805-806.

Tyagi, B.S., Sheoran, J., Singh, G., Gupta, R.K. and Singh S.S. (2009) Prospects and opportunities for cultivation of quality durum wheat in India. Researchj Bulletin, Directorate of Wheat Research, *Indian Council of Agricultural Research*, Karnal.