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Effect of Hydrogel and Foliar nutrition sprays on productivity and profitability of lentil under rainfed situation of south eastern plain zone of Rajasthan

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Abstract

A field experiment was conducted at Agricultural Research Station (Agriculture University), Kota (Rajasthan) during two consecutive winter (*rabi*) seasons (2015-16 & 2016-17). The experiment comprised of 3 hydrogel levels (i.e. 0, 2.5 kg/ha & 5.0 kg/ha) were kept in main plots and 5 levels of foliar nutrition (i.e. water spray, 2 % urea, thiourea 500 ppm, salicylic acid 75 ppm & NPK (19:19:19) @ 0.5 %) in sub plots. Hydrogel was drilled 7-8 cm deep into the soil before lentil sowing in earmarked strips and subsequently foliar nutrition were sprayed at critical stages i.e. flower initiation and pod development. Result revealed that drilling of hydrogel 5.0 kg/ha before sowing recorded significantly higher pods/plant (66.5), grain yield (1210 kg/ha) and net return (Rs. 27507/ha) over control and 2.5 kg/ha, respectively while, maximum B: C ratio (1.41) was fetched with hydrogel 2.5 kg/ha being on par with hydrogel 5.0 kg/ha over no hydrogel. Foliar application of NPK (19:19:19) @ 0.5 % at flower initiation & pod development stages recorded significantly higher pods/plant (63.2), grain yield (1127 kg/ha), net return (Rs. 26646/ha) and B: C ratio (1.44) being on par with salicylic acid 75 ppm over water spray and urea 2 %, respectively.

Keywords: *Foliar nutrition; hydrogel; productivity; profitability; salicylic acid; thiourea; urea*

1 Introduction

Lentil being one of the major *rabi* pulse crop after chickpea in Rajasthan is mainly cultivated with traditional methods under arid and semi arid regions where shortage of water during the crop growth period has become the major impediments for its cultivation. The stress crunch of inefficient use of rain & irrigation water by rainfed crops is the most important problem in semiarid and arid regions. Application of water-saving super absorbent polymers (SAP) i.e. hydrogel into the soil could be an effective way to increase both water and nutrient use efficiency in crops (Lentz *et al.*, 1998). Hydrogel is drilled in the soil before sowing the crop, it is presumed that hydrogel retain large quantities of water and nutrients, which are released as & when required by the plant and it might be that plant growth could be improved with limited water and nutrient supply (Gehring and Lewis, 1980).

Similarly, terminal heat and temperature extremities in the later stages of crop growth during moisture stress especially at pod development stage are the major factors which affect the lentil productivity due to flower drops and unfilled grains in pod. This aberrant weather condition and temperature extremities caused second generation problems in nutrient management under rainfed condition although photosynthesis gets reduced due to depletion of nitrogen in leaves and may lead to acceleration of senescence of leaves (Leport *et al.*, 1998) while pod and seed development are in part depends on carbon and nitrogen accumulated prior to podding (Davies *et al.*, 2000) as roots fail to absorb nitrogen from dry vertisol soils if applied at that time. Under such situations, nitrogen supply can be maintained through foliar application at lower concentration by the bioregulators act as chemical catalyst in plants and improve physiological and reproductive efficiency in the plant. These bioregulators possibly improve the gene expression for efficient sucrose transport and increase dry matter partitioning for grain production (Werdan *et al.*, 1975). Nutrient management (Major & Minor) is the main component for sustainable lentil production along with foliar application of water soluble fertilizers at appropriate stages of growth may also ameliorate the nutrient deficiency as well as mitigate the heat stress. It is therefore to measure the adoption of improved appropriate water conserving technologies for enhancing the productivity and profitability of lentil. Keeping this in view, a field experiment was carried out to find out the effective dose of hydrogel with suitable foliar nutrition at critical stages for enhancing productivity and profitability of lentil under vertisols.

2 Materials and Methods

A field experiment was conducted at Agricultural Research Station of the Agriculture University, Kota (Rajasthan), during two consecutive winter (*rabi*) seasons (2015-16 & 2016-17). The experiment comprised of 3 hydrogel levels (i.e. 0.0, 2.5 kg/ha & 5.0 kg/ha) were kept in main plots and 5 levels of foliar nutrition (i.e. water spray, 2 % urea, thiourea 500 ppm, salicylic acid 75 ppm & NPK (19:19:19) @ 0.5 %) in sub plots. The experiment was laid out in split plot design and replicated three times. The soil of the experimental field was clay loam, slightly alkaline in reaction (pH 7.6), poor in organic carbon (4.1 g/kg), medium in available N (378.5 kg/ha) & K (292.8 kg/ha) and low in available P (8.94 kg/ha) & sulphur (16.1 kg/ha). Hydrogel was drilled in soil before lentil sowing in earmarked strips and subsequently foliar nutrition were sprayed at critical stages i.e. flower initiation and pod development. The recommended dose of fertilizer (20 kg N, 17.5 kg P, 16 kg K/ha, 20 kg S and 5 kg Zn) was drilled in the soil at the time of sowing and seeds were treated with *rhizobium* and *phosphate solubilising bacteria* (PSB) @ 10 g/kg. The lentil variety "IPL 316" was used for experimental purpose and sown on 26th November, 2015 and 16th November, 2016 sown at 30 cm and 5 cm inter and intra row spacing, respectively by adopting the recommended seed rate of 60 kg/ha. Weeds were managed by preemergence herbicide pendimethalin 30 EC @ 1.0 kg/ha + one hand weeding at 35-40 days after sowing. The plant protection measures were taken up as and when required. In each plot five plants were randomly selected and tagged to record biometric observations on growth and yield attributes. At maturity data on plant height, branches/plant, pods/plant, seeds/pod, 1000-seed weight, biological yield and grain yield were recorded. Harvest index was calculated by dividing economical yield by total biomass production. Net returns as well as B: C ratios were also worked out. All data were subjected to analysis of variance.

3 Results and Discussion

3.1 Growth and yield attributes

The results showed that drilling of hydrogel had positive effect on plant growth and yield attributes as compared to no hydrogel drilling in the soil (Table 1).

Table 1. Effect of hydrogel and foliar nutrition on growth and yield attributes of lentil (Pooled data of 2 years)

Treatment	Plant height (cm)	Branches /plant (Nos)	Pods/ plant (Nos)	Seeds/pod (Nos)	Test weight (g)
Hydrogel (kg/ha)					
0	52.1	1.4	49.8	1.4	25.8
2.5	56.2	1.8	59.1	1.5	26.1
5.0	60.1	2.0	66.5	1.5	26.2
SEm±	0.98	0.03	1.48	0.05	0.60
CD (P=0.05)	3.19	0.10	4.83	0.17	NS
Foliar nutrition spray (FI & PD)					
Water spray	51.7	1.5	52.6	1.3	25.7
Urea 2 %	54.7	1.7	56.7	1.4	25.9
Thiourea 500 ppm	56.7	1.8	59.1	1.5	26.0
Salicylic acid 75 ppm	58.2	1.8	60.7	1.5	26.2
NPK (19:19:19) 0.5 %	59.4	1.9	63.2	1.5	26.4
SEm±	0.93	0.08	1.32	0.06	0.42
CD (P=0.05)	2.63	0.24	3.75	0.18	NS

Drilling of hydrogel 5.0 kg/ha before sowing recorded maximum and significantly tallest plant (60.1 cm), number of branches/plant (2.0), number of pods/plant (66.5) and number of grains/pod (1.5) over control and 2.5 kg/ha, respectively. It was registered 15.4, 42.9, 33.5 and 7.1 per cent higher over control, respectively. This might be due to water conservation by hydrogel creates a buffered environment being effectiveness in short term drought tension and losses reduction in early establishment phase in the lentil plant. Hence, super absorbent polymers (hydrogel) causes improvement in plant growth by increasing water holding capacity in soils (Boatright *et al.*, 1997) and delaying the duration to wilting point in drought stress (Gehring and Lewis, 1980).

Therefore, totally proficiency in water consumption and dry matter production are positive plant reactions by the super absorbent application (Woodhouse and Johnson, 1991). Similarly, application of SAPs improved physical properties of soil, water use efficiency, reduced infiltration rate, increased water holding capacity and decreased evaporation losses (Choudhary *et al.*, 1995; Shooshtarian *et al.*, 2012) thus ultimately enhanced growth and yield attributes to increased grain yield of lentil under water scarce condition.

Foliar application of nutrients at flower initiation and pod development stages had positive effect on increasing growth parameters and yield attributes

of lentil. Pooled data further revealed that foliar application of NPK (19:19:19) @ 0.5 % at flower initiation & pod development stages recorded significantly tallest plant (59.4 cm), higher number of branches/plant (1.9), number of pods/plant (63.2) and number of grains/pod (1.5) being on par with salicylic acid 75 ppm over water spray, urea 2 % and thiourea 500 ppm, respectively. The per cent increase to the tune of 14.8, 26.7, 20.1 and 15.4 in respect of plant height, branches/plant, pods/plant and seeds/pod over water spray, respectively. This might be help by foliar spray of NPK 19:19:19 @ 0.5 %, salicylic acid 75 ppm and thiourea 500 ppm increased dark fixation of CO_2 in embryonic tissues of plant has diverse biological activities. Its beneficial effect might be appears due to delayed senescence of both vegetative and reproductive organs as thiourea has cytokinin like activity particularly on delaying senescence (Halmann, 1980). These regulators are also known to increase photosynthetically active leaf surface during grain filling period in cereals (Sahu *et.al.* 1993). Drilling of hydrogel and foliar spray of bioregulators (urea, salicylic acid and multi grade nutrients) did not influenced the test weight significantly over control.

3.2 Yield and economics

Application of hydrogel 5.0 kg/ha was recorded maximum and significantly higher grain yield (1210 kg/ha) and net return (Rs. 27,507/ha) over control and 2.5 kg/ha, respectively (Table 2). It was registered 43.7 and 54.9 per cent higher over control, respectively. Whereas, maximum and significantly higher B: C ratio (1.41) was fetched with hydrogel 2.5 kg/ha being on par with hydrogel 5.0 kg/ha over no hydrogel.

Table 2. Effect of hydrogel and foliar nutrition on yield and economics of lentil (Pooled data of 2 years)

Treatment	Grain yield (kg/ha)	Harvest Index (%)	Net return (Rs/ha)	B: C ratio
Hydrogel (kg/ha)				
0	842	30.27	17757	1.12
2.5	1105	30.47	25805	1.41
5.0	1210	30.82	27507	1.32
SEm±	21.7	0.16	867	0.04
CD (P=0.05)	70.7	NS	2827	0.15
Foliar nutrition spray (FI & PD)				
Water spray	951	30.31	19775	1.08
Urea 2 %	1027	30.52	22746	1.23
Thiourea 500 ppm	1066	30.60	24358	1.33
Salicylic acid 75 ppm	1090	30.58	24924	1.33
NPK (19:19:19) 0.5 %	1127	30.60	26646	1.44
SEm±	18.0	0.22	721	0.04
CD (P=0.05)	51.2	NS	2049	0.11

It may be due to application of super absorbent polymers (hydrogel) improves plant growth by increasing water holding capacity in soils (Boatright *et al.*, 1997) and delaying the duration to wilting point in drought stress (Gehring and Lewis, 1980) thus enhanced growth and yield attributes eventually for harvest higher grain yield of lentil.

Foliar application of nutrients at flower initiation and pod development stages had positive effect on grain yield and economics of lentil. Pooled data further revealed that foliar application of NPK (19:19:19) @ 0.5 % at flower initiation & pod development stages recorded maximum and significantly higher grain yield (1127 kg/ha), net return (Rs. 26646/ha) and B: C ratio (1.44) also being on par with salicylic acid 75 ppm over water spray, urea 2 % and thiourea 500 ppm, respectively. The per cent increase in grain yield was to the tune of 18.5, 9.7 and 5.7 over water spray, urea 2 % and thiourea 500 ppm, respectively. This might be probably spray of NPK 19:19:18 @ 0.5 % and urea 2 % spray improved nitrogen supply to leaf by foliar absorption might have delayed the senescence of leaves and allowed greater soil total assimilation and carbon remobilization to the seeds of additional pods reported by Palta *et al.*, 2005.

4 Conclusions

Two years consecutive study suggests that drilling of hydrogel 2.5-5.0 kg/ha before lentil sowing and subsequently foliar spray of either NPK (19:19:19) @ 0.5 % or salicylic acid 75 ppm at flower initiation and pod development was found effective for increasing grain yield and economics of lentil. Hence, hydrogel along with foliar application of either NPK 19:19:19 or salicylic acid 75 ppm may become a practically convenient and economically feasible and viable option in water-stressed areas for increasing agricultural productivity with environmental sustainability.

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