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Research Article

IMPACT OF MULCHING AND ANTI-TRANSPIRANTS ON PHYSIOLOGICAL PARAMETERS AND YIELD OF SOYBEAN

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Abstract- The experiments were carried out during successive *kharif* season of 2012 - 2014 to investigate the effects of straw mulch and anti-transpirants on physiological parameters and yield of soybean at Millet Breeding Station, Tamil Nadu Agricultural University, Coimbatore. The experiment treatments were arranged in split plot design with four replications. The mulching practices *viz.,* Bajra straw mulch and without mulch were formed the main plot and anti-transpirants *viz.,* Magnesium carbonate (0.5%), Glycerol (5%), Sodium carbonate (2%), Potassium nitrate (1%) and water spray constituted to sub plot. Results showed that enhanced physiological characteristics obtained from bajra straw mulch @ 5 t/ha, while anti-transpirant of potassium nitrate (1%) sprayed at 50% flowering stage which was on par with magnesium carbonate (0.5%) and glycerol (5%). The combined treatments of straw mulch with foliar spray of potassium nitrate (1%), sprayed at flowering stage improved the physiological and yield parameters of soybean. Water stress caused of decreases yield in soybean, but applied of mulches and anti-transpirant materials caused decrease of negative effects of water stress in our experiment and increased values of traits.

Keywords- Water stress, Mulching, Anti-transpirant, Dry matter production, Yield

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Introduction

The wonder crop 'soybean' (*Glycine max* L. Merril) is a leguminous crop and belongs to family *leguminoaceae* with sub family *papillionaceae.* It is also called as "Golden Bean" of the 20th century because of its high nutritive value and regarded a substitute or compliment of protein. It is a unique pulse-cum-oilseed crop consisting about 38-40 per cent and 18-20 per cent oil. Thus it is the major source of edible vegetable oil and high protein feed in food supplement of the world [1]. Soybean is one of the most important oil seed crops and is usually confronted with water deficient stress leading to yield loss [2]. This stress during plant development typically reduces the reproductive allocation to seeds, resulting in fewer and often smaller grains. Stage of plant growth and duration of drought stress are important for the degree of the impact on growth and final yield in soybean. The loss in yield can be minimized if good amount of water is stored in soil. By adopting soil moisture conservation technique water availability and water utilization by crop increased to greater extent. So adoption of the agronomic practices like mulching is helping in reducing water loss from soil [3].

Mulching is a common practice recommended for tropical small farming holder, due to its ability to conserve soil and moisture and also suppress weeds [4]. Mulching increased soil moisture content, improved the soil structure and decreased the weed growth, and thereby enhanced yield in crops [5]. Actively growing plants transpire a weight of water equal to their leaf fresh weight each hour under conditions of arid and semi-arid regions if water is supplied adequately. One way to achieve this goal is to reduce the transpiration rate in order to minimize the amount of irrigation water [6]. Therefore, application of anti-transpirant materials by foliar application can significantly reduce damaged that caused by water stress. The objective of present work was investigation of the effect of mulching and anti-transpirants on physiological parameters and yield of soybean.

Materials and Methods

The experiment was carried out at the research field no. E 10 of Millet Breeding Station, Department of Pulses, Tamil Nadu Agricultural University (11°N and 77°E with an altitude of 426.7 m elevation), Coimbatore during kharif season 2012-2014. The soil of the experimental plot was red sandy loam in texture with 0.51 % organic carbon and 191 kg/ha, 10.3 kg/ha, 392 kg/ha available N, P and K, respectively. Soil was slightly alkaline in reaction (pH-7.89). The experiment was laid out in split plot design and replicated four times. The main plots represented two mulching treatments including bajra straw mulch and without mulch. The subplots were considered with foliar application of anti-transpirant materials followed as: Magnesium carbonate (0.5%), Glycerol (5%), Sodium carbonate (2%), Potassium nitrate (1%) and water spray as control. Soybean seeds (cv. RKS 18) disinfection and inoculation by *Rhizobium Japonicum* bacteria (50 g/kg of seeds) were sown on 25th June 2012, 21st June 2013 and 8th July 2014. Bajra straw mulch @ 5 t/ha was applied to the plots randomly immediately after sowing and spraying of anti-transpirants was done at 50 per cent flowering stage. Seeds were sown in lines at a spacing of 30 cm apart and 10 cm between plants. The recommended dose of 20:80:40:40 kg NPKS/ha in the form of urea, single super phosphate, muriate of potash and gypsum were applied to all plots uniformly in lines and incorporated at the time of sowing. Ten plants were tagged at random in each treatment plot for recording the various physiological parameters and yield of the crop.

Relative water content (RWC) of fully expanded third leaf of soybean was determined by the method suggested by [7] RWC was calculated by using the following formula and expressed in per cent.

$$RWC\ (\%) = \frac{\text{Fresh weight (g) - Dry weight (g)}}{\text{Turgid weight (g) - Dry weight (g)}} \times 100$$

Data from individual experiment was pooled and subjected to analysis of variance using as per standard method prescribed by [8].

Results and Discussion

The results of the present experiment as well as relevant discussions have been presented under following heads:

Dry matter production

The dry matter production (DMP) increased with the age of the crop and reached the highest at harvest. The crop at 45 and 60 DAS showed a phenomenal increase in DMP than the other stages [Table-1]. Bajra straw mulch @ 5 t/ha recorded higher dry matter production of 1.92, 4.80 and 6.80 g/plant at 30, 45 and 60 DAS, respectively. The micro-climatic conditions are favorably affected by optimum degree of soil moisture. When soil surface is covered with mulch, it helps to prevent weed growth, reduce evaporation and increase infiltration of rain water during growing season. The results are in accordance with the findings of [9].

Among the anti-transpirants, foliar application of potassium nitrate (1%) obtained more dry matter production (1.84, 4.71 and 6.50 g/plant) at all stages of observation (30, 45 and 60 DAS respectively), which was comparable with the application of magnesium carbonate (0.5%) and glycerol (5%). With regard to anti-transpirant spray, there was no significant variation at 30 and 45 DAS. However, those stage of crop produced higher DMP due to initial application of mulches and latterly the real effect of anti-transpirant as potassium nitrate directly related to physiological processes in plant and helped in increasing the biomass production and might have contributed for increased yield. This result is in corroboration with that in sweet pepper [8] and cowpea [3].

Table-1 *Effect of bajra straw mulch and anti-tranpirants on physiological parameters of soybean*

Treatment	DMP (g/plant)			Crop growth rate (g/m²/day)		Relative water content (%)		
	30 DAS	45DAS	60 DAS	30 - 45 DAS	45-60 DAS	30 DAS	45DAS	60 DAS
Main plot: Mulching								
M_1 – Bajra traw mulch @ 5 t/ha	1.92	4.8	6.8	12.40	11.61	83.1	84.60	78.3
M_2 - Control (No mulch)	1.52	3.77	5.1	10.68	7.18	75.5	74.50	64.7
SEd	0.05	0.25	0.3	0.74	1.04	1.90	1.46	1.7
CD (P=0.05)	0.15	0.36	0.5	0.85	0.93	8.30	0.27	7.3
Sub plot: Anti-transpirants								
S_1 - Magnesium carbonate (0.5%)	1.81	4.59	6.4	12.15	10.89	78.8	80.1	73.0
S_2 - Glycerol (5%)	1.81	4.53	6.2	12.31	9.84	78.0	79.0	72.0
S_3 - Sodium carbonate (2%)	1.62	4.03	5.4	11.49	7.92	77.0	79.1	68.6
S_4 - Potassium nitrate (1%)	1.84	4.71	6.5	12.69	11.04	70.5	81.5	74.8
S_5 - Control (Water)	1.54	3.56	5.1	9.07	7.29	76.3	78.0	67.7
SEd	0.07	0.31	0.3	0.89	1.17	3.8	2.48	1.6
CD (P=0.05)	0.6	0.37	0.6	1.32	1.20	NS	NS	3.3

Crop growth rate

Crop growth rate (CGR) which represents the time trend of growth was recorded at different phenophases of soybean. Significant difference in crop growth was observed with mulching and anti-transpirant at 30, 45 and 60 DAS of crop [Table-1]. Marked difference in CGR was observed due to the mulching and anti-tranpirant spray. A steady increase in CGR was noticed between 30-45 DAS and a steep decline was noticed CGR at 45-60 DAS. At all the crop growth stages, the bajra straw mulch @ 5 t/ha recorded higher crop growth rate of 12.40 (g/m²/day) at 30-45 DAS. This might be duo to moisture stress on mulched plots in initial and other growth stages. Similar finding was observed by [6] yield was higher in straw mulching than plastic mulch due to more numbers of panicles, crop growth rate and dry matter accumulation.

There was a significant difference in CGR among the foliar spray of anti-transpirant potassium nitrate (1%) was distinctly superior (12.69 (g/m²/day) over other anti-tranpirants in their CGR between 45 and 60 DAS. This was followed by magnesium carbonate (0.5%) and glycerol (5%) sprayed with CGR of 12.31 and 12.15 (g/m²/day) respectively. Potassium regulates the osmotic turgor of cells and water balance, which is driving force for cell division and elongation. Similar results of increase in plant height due to foliar nutrition of KNO_3 and potassium solution during drought was revealed by [11] in chickpea and [12] in greengram.

Relative water content

Relative water content (RWC) is the important moisture stress factor of growth and the observations on this parameter were recorded at 30, 45 and at 60 DAS [Table -1]. In the experiment study, application of bajra straw mulch @ 5 t/ha increased more RWC of 82.1, 84.6 and 78.3 per cent at 30, 45 and 60 DAS respectively. This might to be overcome moisture stress and also cover soil surface around the plants to create suitable condition for the growth. As soil water conditions become more constant, plants are able to utilize water and increase production [13]. At 30 and 45 DAS, foliar spray of anti-tranpirant as potassium nitrate (1%) observed that there was a no marked variation in RWC. However, more RWC values (74.8%) observed at 60 DAS, which was comparable with application of magnesium carbonate (0.5%) and glycerol (5%). Potassium nitrate provides nitrogen and potassium both, which influences the water economy and crop growth, through its effect on water uptake, root growth, maintenance of turgor, transpiration and stomatal behaviour. The obtained results are in good harmony with those of [14].

Rainfall use efficiency

The maximum rainfall use efficiency of 3.30 kg/ha/mm was obtained with the application of bajra straw mulch than compared to without mulch [Table-2]. Foliar spray of potassium nitrate @ 1% (3.25 kg/ha/mm) distinctly superior to all other anit-transpirants which was on par with magnesium carbonate (0.5%) and glycerol (5%) as foliar spray received rainfall use efficiency of 3.18 and 3.13 kg/ha/mm. This might to be increased yield for foliar sprayed anti-transpirant is due to the capabilities to maintain osmotic adjustment, stabilize the growth and development as well as increased efficiency in water uptake by plants. These results are in accordance with the findings of [15].

Table-2 *Effect of bajra straw mulch and anti-tranpirants on rainfall use efficiency and yield of soybean*

Treatment	RUE (kg/ha/mm)	Yield (kg/ha)
Main plot: Mulching		
M_1 - Straw mulch @ 5 t/ha	3.30	1219
M_2 - Control (No mulch)	2.72	1006
SEd	0.09	40
CD (P=0.05)	0.38	112
Sub plot: Anti-transpirants		
S_1 - Magnesium carbonate (0.5%)	3.18	1169
S_2 - Glycerol (5%)	3.13	1167
S_3 - Sodium carbonate (2%)	2.78	1063
S_4 - Potassium nitrate (1%)	3.25	1175
S_5 - Control (Water)	2.70	988
SEd	0.13	62
CD (P=0.05)	0.28	96

Yield

The soybean yield was significantly influenced by mulching and foliar application of anti-transpirant in season of 2012-2014 [Table-2] and [Fig-1]. Yield (1219 kg/ha)

was observed with mulch application of bajra straw mulch @ 5 t/ha as compared to without mulch. This might be due to availability of moisture will increases cell expansion because of turgor pressure and increases of photosynthesis rate, which in turn, increases assimilate production and transportation from source to sink thereby increasing yield components [4].

The maximum yield (1175 kg/ha) was recorded with application of potassium nitrate @ 1% markedly higher to all other anit-transpirants which was comparable with application of magnesium carbonate (0.5%) and glycerol (5%). This result, however, point to the good effect of the anti-transpirants which are biodegradable organic film formulated to protect plants from injury of shock caused by excessive transpiration of water loss through different vegetative plant organs, consequently enhancing the vegetative growth. In this respect, many other investigators had results which in good harmony with [1].

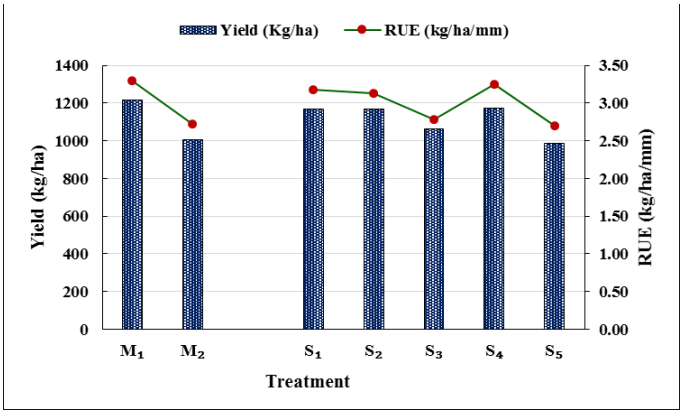

Fig-1 Influence of mulching and anti-transpirant on RUE and yield of soybean

Conclusion

From the results, it can be concluded that bajra straw mulch @ 5 t/ha and foliar spray of potassium nitrate (1%) or magnesium carbonate (0.5%) played a greater role in minimizing evapotranspiration, due to that available water to plants root varied appreciably, adjusted and neutralized negative effect of water stress and increased grain yield of soybean.

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Abbreviations

The following abbreviations are used

DAS: Days after sowing, @: at the rate, N: Nitrogen, P_2O_5: Phosphorus, K_2O: Potassium, S: Sulphur, RWC: Relative water content, %: Per cent, t/ha: tones per hectare, g/kg: gram per hectare, cm: Centimeter, DMP: Dry matter production, CGR: Crop growth rate, g/m^2/day: gram per square meter per day, RUE: Rainfall use efficiency, kg/ha/mm: Kilogram/hectare/millimeter.

Conflict of Interest: None declared

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