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Research Article

Effect of organic mulches and foliar spray of kaolin on NPK uptake in enhancing yield and economics of dry land maize (*Zea mays* L.)

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Abstract
The hot and semi-arid region is prone to meteorological droughts; the lack of rain is frequently accompanied by hot temperatures, strong winds, and low humidity, which has the impact of limiting nutrient uptake and agricultural yields. To overcome this problem a field study conducted during June, 2020 *kharif* season at farmers field, Chinna Dudyala village, Muddanur, Kadapa district, Andhra Pradesh aimed to determine the effect of organic mulches and foliar spray of kaolin on NPK uptake in enhancing yield and economics of dry land maize (*Zea mays*). One of the most important techniques for preserving soil moisture was mulching, which also reduces evapotranspiration when anti-transpirants are used. The experiment comprised nine treatments (T_1 to T_9) with four types of organic mulches viz., Paddy straw, Ground-nut haulm, Coir-pith, and Sugarcane trash, with foliar spray of kaolin intervals on 40 DAS, 20 & 40 DAS and farmers practice to minimize water stress and improve the nutrient uptake by plant. Among the application of the treatments, coir-pith mulch + foliar spray of kaolin @ 3.0% (T_6) on 20 DAS & 40 DAS had significant effect on NPK uptake with N (187.15 kg ha^{-1}), P (69.60 kg ha^{-1}) and K (156.22 kg ha^{-1}) and enhanced grain yield (6976 kg ha^{-1}) and stover yield (10980 kg ha^{-1}), highest gross returns (138034 ₹. ha^{-1}) and BCR (2.63) and was superior to all the other treatments. The present study would help to effectively utilise the available resources, enhance growth and productivity in maize crop and to make economically viable to the farmers of semi-arid regions.

Keywords: Coir pith, Dry land, kaolin, Mulching, Nutrient uptake

INTRODUCTION

Maize (*Zea mays* L.), is the most significant food crop in the world, farmed throughout the year in various ecosystems and seasons. Due to its high-yielding potential, maize is the second-largest cereal crop in the world and is referred to as the "Queen of Cereals." It is also a significant industrial raw material and provides scope for value addition. Area, production and productivity of maize in India accounts of 9.86 M ha, 31.51 M t, 31.95 q ha^{-1} and Andhra Pradesh contributes an area of 0.30 M ha, production of 1.95 M t and productivity of 6438 kg ha^{-1} respectively (Anonymous, 2021). Maize is an exhaustive feeder of nutrients compared with other crops and lack of soil moisture is the major constraint for crop establishment (Chhetri and Sinha, 2019). Soil nutrients, which include nitrogen, phosphorus, and potassium, are essential for crop growth and development and are important factors in soil fertility. To increase crop yield, maize crops require adequate levels of N, P, and K and adequate water for nutrient transport from the soil to the maize roots. In general, moisture promotes nutrient transport and plant growth (Cheng and Zhou, 2019).
Mulch increases plant nutrient uptake efficiency, decreases N discharge losses, and increases soil organic matter (El-beltagi , *et al.,* 2022). Organic mulches en-

hance the aesthetics of landscapes by catching more rain, conserving soil moisture, and improving soil properties and microbial activity, thereby supporting mineralization rate and release of nutrients such as N, P and K into the soil (E.U *et al.,* 2020). Anti-transpirants reflect the radiation, reduce the leaf temperature when sprayed with kaolin-reflective type material (Singh et al., 2021) and reduce the transpiration loss of water occurring mainly through the leaf surface (Kumar *et al.,* 2015) and boosting maize grain yield. Keeping this in the background, a field experiment was carried out to determine the effect of different mulches and foliar spray of kaolin on NPK uptake, yield and economics of maize in the dry land region of Andhra Pradesh.

MATERIALS AND METHODS

The study was carried out during the June 2020 *Kharif* season at a Farmers field Chinna dudyala village, Muddanur, Kadapa district, Andhra Pradesh. It is located at 14.65º N and 78.36º E and altitude of 194 m above the mean sea level. The climate of the region is hot and semi-arid, characterized by average annual rainfall of 570 mm with an air temperature of 26-46º C. The soil of the experimental site was sandy clay loam in texture with particle size 50.1% sand, 15.4% silt and 34.5% clay using International pipette method as suggested by Piper, (1966) and pH of 8.0 alkaline in reaction through Buckman's Zerb metric pH meter and the soil organic carbon 0.40%, was performed using Walkley and Black wet digestion method as suggested by Jackson, (1973), available nitrogen performed by using Alkaline permanganate method as suggested by Subbaiah and Asija, (1956), Phosphorus through Bray's method and Potassium performed by Neutral normal ammonium acetate method as described by Jackson, (1973) and status were 201, 78 and 422 kg ha^{-1} respectively.

Maize hybrid DKC 9133 was sown in June 2020 with a spacing of 60 cm × 20 cm using a seed rate of 20 Kg ha^{-1}. The experiment consisted of nine treatments with four different organic mulch types and with two different foliar spray of kaolin intervals. The plot size was 6 × 5 m^2 by forming ridges and furrows. The experimental design was laid out in Randomized Block Design with nine treatments and three replications, namely, T_1- Paddy straw mulch + foliar spray of kaolin @ 3.0 % on 40 DAS, T_2- Paddy straw mulch + foliar spray of kaolin @ 3.0 % on 20 DAS & 40 DAS, T_3- Groundnut haulm mulch + foliar spray of kaolin @ 3.0 % on 40 DAS, T_4- Groundnut haulm mulch + foliar spray of kaolin @ 3.0 % on 20 DAS & 40 DAS, T_5- Coir-pith mulch + foliar spray of kaolin @ 3.0 % on 40 DAS, T_6- Coir-pith mulch + Kaolin foliar spray of kaolin @ 3.0 % on 20 DAS & 40 DAS, T_7- Sugar cane trash mulch + foliar spray of kaolin @ 3.0 % on 40 DAS , T_8- Sugar cane trash mulch + foliar spray of kaolin @ 3.0 % on 20 DAS & 40 DAS, T_9- Farmers practice (No Mulch). Nitrogen (N), phosphorus (P), and potassium (K) fertilisers were applied at a rate of 200:60:50 kg ha^{-1}. The half N, full doses of P and K were applied as a basal application and the remaining half N was used as a top dressing. The mulch material was placed in furrows at 10 DAS according to the treatment plan. According to the treatment schedule, the foliar spray of kaolin were sprayed at 40 DAS, 20 DAS, and 40 DAS intervals. Based on the standard guidelines for maize cultivation, all additional agricultural operations, such as weed and pest management and fertilizer applications, were performed simultaneously and uniformly for all treatments.

Plant analysis for nutrient content in crops affected by different crop cultures and integrated plant nutrition was performed using Conc. H_2SO_4 digestion and distillation for total nitrogen as suggested by Yoshida *et al.* (1976) and Tri-acid digestion for total P and K as described by Jackson (1973).

Mean data obtained from various studies was statistically analysed in randomized block design (RBD) using the technique of analysis of variance (ANOVA). The difference between the treatment means were tested as to their statistical significance with critical difference (CD) value at 5%. The economics was computed using prevailing prices of inputs and outputs.

RESULTS AND DISCUSSION

Plant nutrient uptake

The maize plant nutrient uptake of N, P & K were significantly affected due to various organic mulches and kaolin foliar spray at various intervals, as shown in Table 1. Among the treatments (T_1 to T_9), coir-pith mulch + foliar spray of kaolin at 3.0% on 20 DAS & 40 DAS (T_6) has up taken more nutrients of N (187.15 kg ha^{-1}), P (69.60 kg ha^{-1}) and K (156.22 kg ha^{-1}) significant with paddy straw mulch + foliar spray of kaolin @ 3.0% on 20 DAS & 40 DAS (T_2) with N (172.46 kg ha^{-1}), P (63.68 kg ha^{-1}) and K (146.79 kg ha^{-1}) and this was at par with coir-pith mulch + foliar spray of kaolin at 3.0% on 40 DAS (T_5) of N (170.65 kg ha^{-1}), P (64.03 kg ha^{-1}) and K (144.06 kg ha^{-1}) were significantly superior compared with all the other treatments.

Coir-pith mulch and paddy straw mulch, along with foliar spray of kaolin affects soil moisture. It creates a better environment for nutrient availability to increase crop growth, nutrient influx and more absorption and translocation of these nutrients to higher grain and stover yield may be the cause of the maximum uptake of nitrogen, phosphorus, and potassium that was observed there. It is well known that an ideal moisture supply encourages crop development and dry matter production both directly and indirectly by improving nutrient availability, usage, and maize uptake. As a result of decreased

Table 1. Effect of Organic mulches and foliar spray of kaolin on plant nutrient uptake

Treatments	N (kg ha^{-1})	P (kg ha^{-1})	K (kg ha^{-1})
T_1: Paddy straw mulch + foliar spray of kaolin @ 3.0 % on 40 DAS	155.44	56.82	132.47
T_2: Paddy straw mulch + foliar spray of kaolin @ 3.0 % on 20 & 40 DAS.	172.46	63.68	146.79
T_3: Groundnut haulm mulch + foliar spray of kaolin @ 3.0 % on 40 DAS	128.24	46.25	109.82
T_4: Groundnut haulm mulch + foliar spray of kaolin @ 3.0 % on 20 & 40 DAS	142.31	52.36	121.49
T_5: Coir-pith mulch + foliar spray of kaolin @ 3.0 % on 40 DAS	170.65	64.03	144.06
T_6: Coir-pith mulch + foliar spray of kaolin @ 3.0 % on 20 & 40 DAS	187.15	69.60	156.22
T_7: Sugar cane trash mulch + foliar spray of kaolin @ 3.0 % on 40 DAS	140.00	51.13	119.33
T_8: Sugar cane trash mulch + foliar spray of kaolin @ 3.0 % on 20 & 40 DAS	157.54	58.01	134.33
T_9: Farmers practice (No mulch)	115.33	41.15	100.01
S.Ed	4.98	1.79	3.87
C.D	10.56	3.80	8.20

Table 2. Effect of Organic mulches and foliar spray of kaolin on yield and economics

Treatments	Grain yield (kg ha^{-1})	Stover yield (kg ha^{-1})	Gross returns (₹ ha^{-1})	B:C
T_1: Paddy straw mulch + foliar spray of kaolin @ 3.0 % on 40 DAS	5895	9650	116830	2.26
T_2: Paddy straw mulch + Kaolin foliar spray of kaolin @ 3.0 % on 20 & 40 DAS.	6583	10464	130309	2.47
T_3: Groundnut haulm mulch + foliar spray of kaolin @ 3.0 % on 40 DAS	4877	8301	96814	1.83
T_4: Groundnut haulm mulch + foliar spray of kaolin @ 3.0 % on 20 & 40 DAS	5460	9102	108291	2.01
T_5: Coir-pith mulch + foliar spray of kaolin @ 3.0 % on 40 DAS	6420	10275	127118	2.47
T_6: Coir-pith mulch + foliar spray of kaolin @ 3.0 % on 20 & 40 DAS	6976	10980	138034	2.63
T_7: Sugar cane trash mulch + foliar spray of kaolin @ 3.0 % on 40 DAS	5308	8875	105290	2.11
T_8: Sugar cane trash mulch + foliar spray of kaolin @ 3.0 % on 20 & 40 DAS	5988	9775	118660	2.33
T_9: Farmers practice (No mulch)	4479	7715	88959	2.12
S.Ed	165.1	224.1	-	-
C.D	350	475	-	-

transpirational loss and greater transfer of photosynthates to the sink, the plant had access to sufficient moisture in water-scarce regions. These results are somewhat concorded with (Ganesh and Kumar, 2016) in onion and cassava (Rajput *et al.,* 2014) in maize and (Balwan *et al.,* 2017) in wheat.

Yield and economics

The yield and economics viz., grain yield, stover yield, gross returns, net returns and B:C ratio varied significantly due to the application of different organic mulches and kaolin foliar spray at different intervals, as mentioned in Table 2. Among the treatments, application of coir-pith mulch + foliar spray of kaolin@ 3.0% on 20 DAS & 40 DAS (T_6) registered with higher grain yield (6976 kg ha^{-1}), stover yield (10980 kg ha^{-1}), gross returns (138034 ₹. ha^{-1}) and B:C ratio (2.63) significant with paddy straw mulch + foliar spray of kaolin @ 3.0% on 20 DAS & 40 DAS (T_2) with grain yield (6583 kg ha^{-1}), stover yield (10464 kg ha^{-1}), gross returns (₹.130309 ha^{-1}) and B:C ratio (2.47) and this was at par with coir-pith mulch + kaolin clay foliar spray at 3.0% on 40 DAS

(T_5) with grain yield (6420 kg ha^{-1}), stover yield (10275 kg ha^{-1}), gross returns (₹.127118 ha^{-1}) and B:C ratio (2.47) and was superior with all the mulching treatments and farmers practice (T_9).

The improved physical condition of the soil, which favourably increased nutrient uptake by the crop by steady and slow rate of nutrient release, which supplies sufficient amount of N, P, and K resulting in high yield and economics, is to be held responsible for the significant increase in yield and economics over other mulching materials. With the application of anti-transpirants, the harvest index was increased, possibly due to maintaining relative plant moisture and reducing transpiration water loss, thus improving metabolic, enzymatic and protein synthesis activity under drought stress. Applying coir pith and kaolin boosted plant water potential during the flower development and reduced transpiration loss, increasing maize production. Coir pith mulching resulted in higher grain yield when compared to all other mulches in semi-arid region. These results are somewhat concorded with the work of Muti *et al.* (2017) for maize, Akhila *et al.* (2018) for okra and Patel *et al.* (2019) for rice.

Conclusion

The present study concluded that the application of (T_6) coir-pith mulch + foliar spray of kaolin @ 3.0% on 20 DAS & 40 DAS to the maize (*Zea mays* L.) crop significantly produced high nutrient uptake, higher yield and economics compared with all the other treatments. As coir-pith naturally incorporates into the soil and helps to lower soil temperature and allows moisture to permeate the soil more evenly, kaolin clay reflects the radiation, and helps to reduce transpiration by lowering leaf temperature. This combination provides the ideal environment for the soil and plants required for sustainable crop production.

Conflict of interest

The authors declare that they have no conflict of interest.

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