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Influence of Residues Level, Parts and Duration of Decomposition of Some Major Broadleaved Weeds on Germination and Early Seedling Growth of Maize (*Zea mays*)

Alemayehu Ayele[1*] J. J. Sharma[2] Lisanework Nigatu[2]
1.Agricultural Technical Vocational Education and Training College, Wolaita Soddo P.O. Box 120
2, Haramaya University, School of Plant Sciences, P.O. Box 138, Dire Dawa, Ethiopia
E-mail: Wondoalem@yahoo.com

Abstract
A greenhouse experiment was conducted at International Livestock Research institute (ILRI), Wolaita Soddo during 2012-13 with the objective of investigating the effect of soil incorporated Benghal dayflower (*Commelina benghalensis* L; Commelanaceace) and Thorn apple (*Datura stramonium* L.; Solanaceae) root and whole plant residues and their duration of decomposition on germination and early growth of maize (*Zea mays* L.). The soil was unamended and amended with the root and whole plant dry residues at the rate of (5, 10, 20, 40 g/ kg soil) and exposed for three different decomposition periods (0, 2 and 4 weeks) in Completely Randomized Design with 3 replications. None of the treatments was affects the germination of maize significantly. Whereas, the root length of maize seedling was significantly affected by the weed part, amount of residue incorporation and duration of decomposition period and the shoot length and dry matter weight of maize seedling was also significantly affected by the weed part of *C. benghalensis,* amount of residue incorporation due to both weeds and duration of decomposition period due to *D. stramonium* 10 days after maize planting.
Keywords: Allelopathy**,** *Commelina benghalensis***,** *Datura stramonium***,** *Zea mays*, residue decomposition.

Introduction

Maize (*Zea mays* L) is one of the most important cereals cultivated in Ethiopia. It ranks second after teff (Eragrostic teff) in area coverage and first in total production. Out of the total grain crop producing areas, 78.6% (9,588,923.71 ha) was under cereals. Of this maize covered 21.4% (about 2,054,723.69 hectares) and gave 6069413 tonnes (t) of grain yield (CSA, 2012/13). Despite the large area under maize, the national average yield of maize is about 2.95 t/ha (CSA, 2012/13), which is very low compared to world average yields of 5.22 tones/ ha (FAOSTAT, 2012).

Earlier weed loss assessment estimated show that grain yield reduction due to weed interference in maize can be as high as 58.1 % (Rezen, 1985). General, the presence of weeds for the 1st 6 ,9,and 12 wks after sowing and for the entire growing season of maize resulted in estimated yield losses of 36,61,80, and 85%, respectively (Assefa,1999). There are about 100 weed species in 66 genera and 24 plant families known to be problematic for maize in Ethiopia (Rezene, 1985).

Allelochemicals refer mostly to the secondary metabolites produced by plants and are byproducts of primary metabolic processes (Levin, 1976). The chemicals can be found in leaves, flowers, pollens, roots, fruits, stems and seeds (Rice, 1974). The allelochemicals can be released from living leaves as volatiles or leachates, exudation from roots, leaching from plant litter, and decay of plant residues. Few chemicals may volatilize and are absorbed directly from the atmosphere by neighbouring plants, while in leaching the water soluble substances from plants are removed by the action of water solvents like rain, dew and fog (Turky Jr., 1970).

Benghal dayflower (*Commelina benghalensis* L; Commelanaceace) and thorn apple or Jimson weed (*Datura stramonium* L.; Solanaceae) has posed a great threat to the production of the crops and has drawn the attention towards this problem. The seed and leaf washings of *D. stramonium* reduced the germination and seedling growth of flax owing to the presence of scopolamine and hyoscyamine alkaloids (Lovett *et al*., 1981) and sunflower (Levitt *et al*., 1984). Thus, the plant residues are inadvertently added to the soil during field preparation each year and there is little time gap between the incorporation of weed residues and sowing of the crop.

However, little is known about the allelopathic potential of *C. benghalensis,* and *D. stramonium* on maize seed germination, seedling growth and biomass production.

Germination and seedling growth response of maize to *C. benghalensis,* and *D. stramonium* plant residues, therefore, may be a solution in the development of natural weed control and management strategies. Therefore, an investigation was carried out under greenhouse conditions, at International Livestock Research institute (ILRI) at Wolaita Soddo site, respectively, with the following objectives.

- To find the influence of soil incorporated plant residues and their duration of decomposition on germination and early growth of maize plant.

Experimental Procedures

A greenhouse experiment were conducted at International Livestock Research institute (ILRI), Wolaita Soddo during 2012-13 with the objective of investigating the influence of soil incorporated Benghal dayflower (*Commelina benghalensis* L; Commelanaceace) and Thorn apple (*Datura stramonium* L.; Solanaceae) root and whole plant residues and their duration of decomposition on germination and early growth of maize (*Zea mays* L.). The weed part was prepared by uprooting the spp. and dried in shade place and separated in to root and whole plant part and cutting in to smaller parts and grounded by using mortar and pistil and sieved by < 0.02mm sieves. The soil was unamended and amended with the root part or whole plant part dry residues at the rate of (5, 10, 20, 40 g/ kg soil) and exposed for three different decomposition periods (0, 2 and 4 weeks) in Complete Randomized Design with 3 replications.

Data on germinated seed (%) was recorded daily from the fourth to tenth day after sowing. On tenth day after sowing root (the sum of all roots) and shoot length (cm) as well as dry matter (mg) were recorded. The seedling vigour was determined by multiplying germination percentage with the sum of root and shoot length (vigour index I) and dry matter weight of seedlings at 10th day (vigour index II).

Result and Discussion

Seed germination %

The analysis of variance showed no significant variation in maize seed germination% at 10th days after planting due to weed part, dry residue incorporated into the soil and their duration of decomposition due to the two weed (Table 1). This might be due to more time required for the release of phenolics from the incorporated plant residues of the two weeds, and the released phenolics from residues might be well below the optimum inhibition level to affect the germination; hence it might fail to alter the germination significantly. This corroborats with the finding of Butnariu (2012) who found alkaloid in *D. stramonium* and the germination was not affected by any of the tested extracts.

Influence on Root length (cm/seedling)

The results revealed that *C. benghalensis* root part dry residue incorporation shows more pronouns influence on root length reduction compared with the whole plant residues by 9.6cm. There was also a significant decreased was observed on root length with increasing the amount of dry residues, this reduction was 18, 32.8, 38.05 and 43.3%, due to 5, 10, 20 and 40g residue /kg soil, respectively compared with the control. There was decreasing trained was observed with increasing the duration of decomposition was extended (Table 1).

The root length shows reduction due to *D. stramonium* whole plant parts compared with its root residues, which is 12.9% lower an influence observed due to whole plant dry residues. Similar to *C. benghalensis* with increasing the amount of residues of *D. stramonium* there was also a significant reduction of root length where observed. It was observed that the parts of the weeds introduced in the soil, amount of residues level and duration of decomposition period of *D. stramonium* was more reduction effect on root development than *C. benghalensis* (Table 1).

The shorter root length of maize was observed with increased the duration of decomposition period. This might have happened due to the release of sufficient phenolics to alter the elongation of roots. The reduction in root length might indicate that cell division was affected as allelopathic chemicals inhibit gibberellin and indoleacetic acid function in the plant (Tomaszewski and Thimann, 1966).

Influence on Shoot length (cm/seedling)

The seedling shoot length was significantly decreased due to whole plant residues of *C. benghalenesis* as compared to root residues and this decrease was 22.9% (Table 1). Like seedling root length, there was also reduction in shoot length of maize with increase in residue incorporation in to the soil. The soil amendment with 40 g residues/ kg soil gave significantly shorter shoot length than the other rates. However, no significant difference was observed between the rates of 5 and 10 g residue/kg soil. Similar influence was also noticed between rates of 10 and 20 g residues/kg soil. Residue incorporation at all the rates significantly reduced the seedling shoot length over the control. The reduction in the growth of maize seedling might be attributed to the presence of phytotoxic phenolics in the amended soil (Batish *et al*., 2002).

The shortest seedling shoot length was obtained due to the effect of 40 g residue/kg and there was a decreasing trend on shoot length with increasing the amount of *D. stramonium* dry residues incorporation and with increasing duration of decomposition, but 2week duration of decomposition was no significant difference with the other decomposition period (Table 1).

Effect on Dry Matter Weight (mg/seedling)

It have been observed that *C. benghalensis* dry root residues resulted the lower dry matter accumulation by 7.5% dry matter weight accumulation than whole plant part dry residues. There was the reduction of dry matter accumulation with increasing the amount of dry residues, 40g dry residues incorporation /kg soil shows the lowest dry matter accumulation the same trend was observed due to *D. stramonium* Table 1.

The higher seedling dry matter weight was obtained from weed residue without any duration of decomposition might be due to insufficient amount of released allelochemicals to bring about a change in dry weight accumulation by maize seedlings, while at four weeks of decomposition the released allelochemicals might have been subjected to loss either due to volatilization and or metabolization by the microorganisms present in the soil. Thus, two weeks decomposition period resulted in more deleterious effect on the seedlings and accumulated less dry matter weight in *C. benghalensis*. This indicated that in areas infested with *C. benghalensis* the incorporation of residues in to the soil through tillage should be done much before sowing of the crop to preclude the expected inhibition of seedling growth of maize due to allelochemicals released from the residues.

Vigour Index I

The mean vigour index I of maize seedling decreased due to the incorporation of root parts dry residues, the reduction was by 1% and 6.5% due to *C. benghalensis* and *D. stramonium*, respectively.

The mean vigour index I of maize seedling decreased more due to the increase of dry residues of the two weeds and this decrease was 20.9, 33.4, 38.8, and 47.7%, due to the incorporation of *C. benghalensis* and in *D. stramonium* it was 10.2, 43.3, 64.1, and 71.9%, respectively, with the increase in amount of dry resides over the control (Table 2).

The seedling vigour index I is governed by percentage of seed germination and the seedling growth (root + shoot) in terms of length. Therefore, the allelopathic inhibition of germination and seedling growth of maize, grown in different amount of weed dry residues resulted variation in seedling vigour index 1. The difference in seedling vigour index I in different weeds might most probably, be due to the difference in allelopathic activity/ability of each weed in suppressing the seed germination and the growth of root and shoot of the maize plant (Table 2).

Vigour index II

Similarly, the seedling vigour index II was decrease with the increasing the amount of dry residues incorporation in the soil. The decrease in vigour index II due to the increase the amount of dry residues of *C. benghalensis* and *D. stramonium* was 19.8, 25.2, 27.6 and 39.1%; 15.0, 15.0, 20.0 and 31.9%, respectively, at the residue amount of 2.5, 5, 7.5, and 10% over the control. Between the two weeds *C. benghalensis* shows more negative effect than *D. stramonium* on vegiour index ii. The lower vigour with in the weeds might be due to the difference in the allelopathic potential of the weeds on the germination, and dry matter accumulation (Table 2).

Conclusion

It can be concluded that the residue incorporation into the soil and their duration of decomposition might contain allelochemicals with detrimental effect on the growth and vigour of maize. However, the magnitude of allelopathic effects was species specific. In general, root part dry residues of *C. benghalensis* have been more damaging effect than that of *D. stramonium* in comparison to whole plant part. It was observed that with increasing the amount of dry residues there was the decreasing trend on root and shoot length and also with increasing the time of decomposition period there was a decreasing on vigour I and ii. Therefore, to preclude the possible adverse effects of secondary metabolites from the decaying residues of the weed species if any on crops, the sowing of maize should be done at least 25-30 days after incorporation of the weeds into the soil.

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Table 1. Influence of weed parts, residue level and its duration of decomposition period on maize seed germination, Root and Shoot length, dry matter weight 10 day after planting.

Weed part used as residues	Germination %		Root length(cm/plant)		Shoot length(cm/plant)		Dry matter weight(mg/plant)	
	1	2	1	2	1	2	1	2
Whole plant	96.7	100.0	10.4	7.4	2.46	2.7	33.2	34.0
Root	97.8	98.9	9.4	8.5	3.19	2.7	30.7	34.0
LSD(0.05)	NS	NS	0.53	0.4	0.18	NS	1.15	NS
Residue (g/kg soil)								
Control	100.0	100.0	13.4	13.4	3.87	3.87	40.0	40.0
5.0	97.2	100.0	11.0	12	3.06	3.5	33.0	34.0
10.0	97.2	100.0	9.0	6.8	2.84	3.0	30.8	34.0
20.0	97.2	100.0	8.3	4	2.57	2.2	29.8	32.0
40.0	94.4	97.2	7.6	3.3	1.78	1.7	25.8	28.0
LSD(0.05)	NS	NS	0.83	0.63	0.29	0.15	1.82	1.33
Duration of residue decomposition(week)								
0	100.0	100.0	10.7	8.2	2.9	3.0	32.6	33.2
2	96.7	100.0	9.9	7.8	2.8	2.9	29.7	33.9
4	95.0	98.3	9.0	7.8	2.7	2.8	33.5	33.5
LSD(0.05)	NS	NS	0.64	0.49	NS	0.11	1.41	NS
CV%	12.12	5.29	12.6	12.01	15.47	7.63	8.53	5.98

LSD = least significant difference, CV = Coefficient of variation, 1=*C. benghalensis,* 2=*D. stramonium*

Table 2. Influence of weed parts, residue level and its duration of decomposition period on seedling vigour index 10 days after planting of maize

Parts	*C. benghalensis*		*D. stramonium*	
	Vigour index I	Vigour index II	Vigour index I	Vigour index II
Whole plant	1243.562	3210.44	1010	3400
Root	1231.302	3002.5	1107.7	3362.6
Residues (g/kg soil)				
Control	1727.0	4000.0	1727.0	4000.0
5	1366.6	3207.6	1550.0	3400.0
10	1150.8	2993.8	980.0	3400.0
20	1056.6	2896.6	620.0	3200.0
40	885.5	2435.5	486.0	2721.6
Duration of decomposition (week)				
0	1360.0	3260.0	1120.0	3320.0
2	1228.1	2871.9	1070.0	3390.0
4	1111.5	3182.5	1041.0	3293.1