IAR PROCEEDINGS

FIRST ETHIOPIAN HORTICULTURAL WORKSHOP

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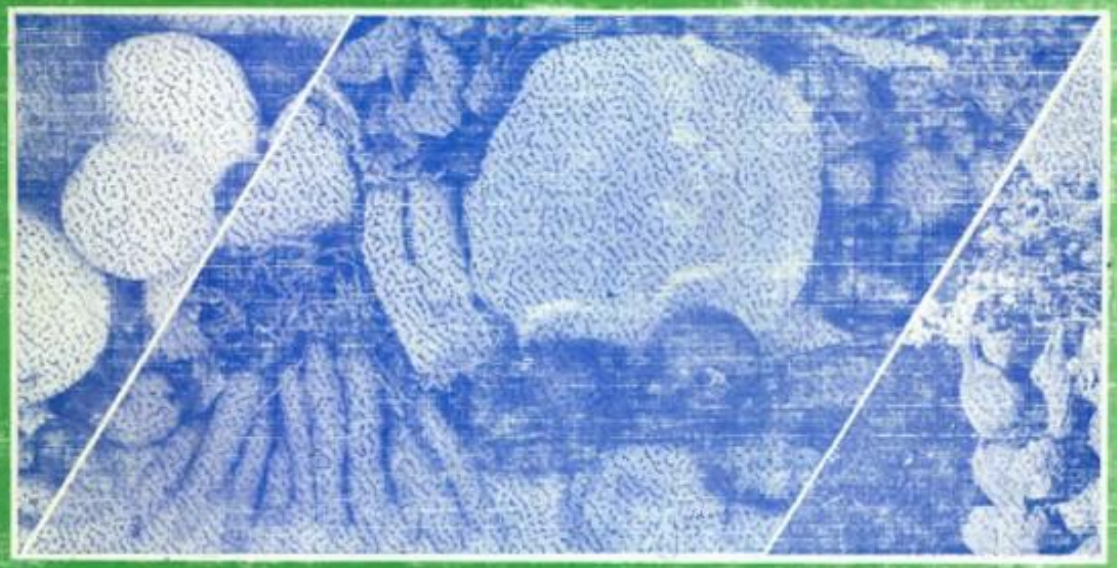

INSTITUTE OF AGRICULTURAL RESEARCH

REVIEW OF POTATO RESEARCH IN ETHIOPIA

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INTRODUCTION

It is not by chance that precisely the potato has come to play an important part in more and better food supply. This tuber is so structured that it is a supplier not only of carbohydrates, necessary for body heat and work output, but also of high quality protein that the body can easily absorb. In addition to a number of minerals and nutrients salts, the potato contains several vitamins from group B and large amounts of the vital vitamin C (FAO, 1980).

If carefully grown, it gives the highest yield of nourishment per hectare of all basic foodstuffs in tropical and bus-tropical countries. Furthermore, the production period is only 90-125 days, enabling optimum use of the available agricultural land. In many regions, a second crop is possible in addition to potatoes on the same field in the same year.

This song of praise to the potato does not incidentally mean that cultivation of potatoes presents no problems. Many pests and diseases threaten the potato crop such as late blight, bacterial wilt, potato tuber moth (PTM), viruses etc. Moreover, its low multiplication rate i.e. 1:10 while for small creals 1:50 to 1:80 is accepted, bulkiness of the tubers and storage problems contribute to a high seed cost and limit the expansion of this important food crop.

Ethiopia has a very suitable climatic and edaphic factors for quality production of high quality ware and seed potatoes. However, the national average yield is said to be 5.3 tons/ha. This is very low when compared with world average yield of 15 tons/ha.

There may be several reasons for the very low yield in Ethiopia. However, the major problems encountered in the production and research are:

1. Lack of high-yielding adapted varieties: Although some very promising varieties or clones are identified and released for production in view of the potential production agro-ecological zones, little has been done in selecting promising clones for different agro-ecological zones.

2. Disease and pests: The potato crop is a victim of many diseases and pests such as late blight, bacterial wilt, potato tuber moth, viruses etc.

3. Lack of seed source: Up to now, there is no a single institute which is mandated to increase seed potatoes at the national level. Therefore, farmers are obliged to use local potatoes which are poor-yielding and susceptible to late blight.

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4. Poor agronomic practices: Too deep cultivation, improper planting methods, poor fertilization of potato land etc., are some of the shortcomings.

5. Lack of storage facilities for seed and ware potatoes. Backward storage systems used by many farmers contribute to severe losses of potatoes in storage.

6. Lack of well-coordinated extension activities.

   This situation has created difficulty in disseminating research results to users (farmers).

7. Lack of sufficient fund and personnel.

   The project has a very acute shortage of fund and skilled personnel to conduct a sound research and extension activities at the national level.

To alleviate the major obstacles in potato production and initiate its expansion in Ethiopia, the College of Agriculture, Addis Ababa University (AAU), in cooperation with the Institute of Agricultural Research (IAR) of Ethiopia and the International Potato Center (CIP) developed a potato project in 1975.

The major objectives of the potato project are:

1. To evaluate and screen potato germplasm for yield, disease and insects resistance.

2. To evaluate potato cultivars which are adapted to different agroecological zones.

3. To determine best agronomic practices for potato production.

4. To evaluate the best and economical storage system.

5. To adopt the use of true potato seed production.

6. To study important diseases and pests and their control measures.

GERMPLASM EVALUATION

During the first phase of the project, seedling introductions representing *Solanum andigenum* X *S. tuberosum*, *S. andigenum*, *S. tuberosum* X *S.phureja* and *S. tuberosum* X *S. tuberosum* crosses were obtained in a form of true botanical seeds from the International Potato Center (CIP) and the screening work had undergone several cycles of selections. Furthermore, different clonal and varietal introductions were made from Kenya, Mexico, USA, the Netherlands etc. At present there are about 324 potato introductions at Alemaya.

The materials obtained from different sources were initia-ly evaluated for yield, late blight, earliness and other horticultural characteristics on a single hill basis on either five or ten hills depending on the number of tubers available before they were advanced to pre-national yield trial. In the pre-national yield trial yield late blight reaction was the major criterion for selection. From Table 1, CIP-378501-7, CIP-378371-5 and CIP-378371-4 gave highest yield respectively as compared with the other cultivars and at the same time they showed a high field resistant to late blight. After observing them critically for at least two seasons of planting they were advanced to national yield trial to be tested under different agro-ecological zones.

NATIONAL YIELD TRIAL

Potato clones or varieties which have shown desirable horticultural characteristics and other criteria of selection such as yield, lage blight resistance etc. were included in the national yield trial to be evaluated under different environmental conditions.

The advanced materials are tested at about 10 collaborating stations which are situated in different agro-ecological zones of the country every year.

The summary of yield and late blight reactions of some potato cultivars at four locations from 1980 to 1983 (Table 2, 3, 4 and 5) showed that in each location, the best adapted cultivars were as follows:

Alemaya	Debre Zeit	Holetta	Bako
A1-624	A1-601	A1-204	A1-601
A1-253	A1-615	A1-624	A1-578
A1-601	A1-148	A1-148	A1-646
A1-264	A1-624	A1-615	A1-615
A1-148	A1-204	A1-253	A1-624

Tables 2, 3, 4 and 5 show the summaries of details at the various locations.

Their reaction to late blight varies from moderate-resistant to high field resistance. Furthermore, the mean yield of the national yield trial at four locations revealed that with respect to yield A1-601, A1-624, A1-615, A1-204, A1-148 and A1-578 were the best top cultivars respectively. Critical evaluation of these cultivars under lanoratory and field conditions revealed that A1-148 and A1-204 have high field resistance to late blight while A1-601, A1-624, A1-615 and A1-578 were moderately resistant to late blight (Solomon Yilma *et al.*, 1984).

Based on two and three years of trials in different locations, the following cultivars were identified to be best adapted to each of the following locations:

Kulumsa	Jimma	Nazareth	Awassa
A1-624	A1-556	A1-624	A1-148
A1-580	A1-204	A1-204	A1-624
A1-253	A1-580	A1-578	A1-615
A1-615	A1-601	A1-563	A1-580
A1-563	A1-646	A1-580	A1-563

Through years of selections as shown from the tables presented, the yielding abilities and blight reactions of some potato genotypes are encouraging and outstanding. Therefore, to exploit the merits of the best potato genotypes and to optimize potato production in the country, establishment of a seed production agency, which would multiply seed potatoes and deliver them to the users (farmers), is a crucial question and needs due consideration.

DEMONSTRATION AND OBSERVATION TRIALS

Best genotypes, which are found to be high yielders and resistant to late blight, were tested on farmers' fields each year around the main stations. The results from the demonstration trials revealed that the newly-improved varieties were found to be highly superior compared with the local cultivars. In view of this fact, the demand for improved seed potatoes by the farmers is extremely high. This condition has resulted in the need for multiplying seed potatoes and thus the establishment of a seed production scheme in the regions.

Regarding observation trials, based on our long-term plant to expand and identify potato producing area, some potato cultivars were planted in the different agro-ecological zones and the results were found to be encouraging at some stations. Since there is a flow of planting material from Alemaya only, shortage of planting material limited the testing sites. Therefore, there is a need for the establishment of variety multiplication sites in different important locations in order to increase the elite planting material for research and production purposes.

AGRONOMY TRIALS

To optimize potato productivity, a full package of information is required with respect to production. One of the major problems related to low yield of potatoes in Ethiopia is inadequate agronomic practices by farmers. To minimize the loss due to improper methods of growing potatoes, research activities were carried out in the past.

The major agronomic research activities include the following:

1. The effect of planting depth and tuber size on tuber yield of potatoes.
2. The effect of inter- and intra-row spacing on the yield of potatoes.
3. The effect of desprouting on tuber yield of potatoes.
4. Effects of method of planting on tuber yield of potatoes.
   - 4.1 Hilling VS non-hilling
   - 4.2 Single and multiple row planting

Quite satisfactory results were obtained from each trial. A compiled report, which will be of paramount importance to farmers, will be published in due course.

STORAGE TRIALS

Lack of proper storage facilities is one of the main factors forcing most farmers to sell their potatoes on harvesting, even at low prices. Due to the high perishability of the potato and poor storage facilities and methods, most farmers cannot store potatoes for a long time without encountering big losses. To minimize losses due to storage two approaches were made, namely,

1. Use of diffused light store.
2. Extended harvesting.

1. Use of Diffused Light Stores

The newly-improved low-cost storage system has enabled most farmers to maintain their seed potatoes for a relatively longer period of time with minimum loss. To exploit the advantages of this construction, five diffused light stores were constructed at Alemaya, Legambo, Nazareth, Debrezeit and Holetta for research purposes. Due to lack of experimental materials, storage trials were conducted only at Alemaya and Legambo. The results of the trials revealed that significant losses were observed in storing potatoes in burlap sacks as compared with storing on the shelves of diffused light store. The stores can, therefore, be modified according to local needs and can also be constructed using locally available materials. Research in different locations with different modification should be initiated.

2. Extended Harvesting Trial

Most farmers in many potato growing regions leave the potatoes in the ground without harvesting them. This type of storage is not very convenient especially in those areas where frost and pests are a great problem in farmers' fields. Research was initiated to observe the losses encountered in extended harvesting of potatoes. Due to alternating of high rainfall and drought problems, the trial has not been successful for the last two years. However, from preliminary observations, it was observed that as long as the tubers stayed for longer period of time, the loss of tubers were very high.

TRUE POTATO SEED (TPS) RESEARCH

Potato production information emerging from research revealed that utilization of TPS for production is an alternative approach to the traditional method of tuber planting. This approach is extremely important in developing countries where quality is not a major concern. This method attracts attention in that it seeks to combine advantages of planting TPS and the conventional methods of planting seed tubers. As it is being developed at CIP and AAU, College of Agriculture, the method provides first generation tubers for multiplication by replanting to increase the seed tuber supply or by planting to produce consumer potatoes (CIP circular, 1981).

Another way to use TPS is producing consumer potatoes by either direct seeding or transplanting.

Some of the advantages of TPS production are:

a. TPS does not transmit most tuber-borns diseases, thus planting material originating from it would be relatively healthy.

b. Transport and distribution costs of TPS are much lower than for tubers.

c. Minimizes storage problem.

d. Reduces seed cost.

However, producing potatoes from botanical seed of potato has its own drawbacks. Some of the limiting factors are, lack of uniformity in tuber skin colour, shape of tuber etc., poor germination percentages, poor survival value, production of unmarketable tubers etc. To alleviate the major problems in TPS production, different trials were executed at Alemaya, namely;

a. The influence of different techniques of transplanting.

b. Intra-row spacing trial with TPS plants.

c. The influence of method of fertilizer application on the yield of OP seedlings of potatoes.

d. The effect of time of fertilizer application on tuber yield of OP seedlings of potato.

e. The effect of different time of watering TPS seedlings on the yield of potato tubers.

f. Parental evaluation of potato tubers derived from TPS.

g. The effect of number of seedling per hill on tuber yield of potato.

h. Production of seed tuber from OP seedlings.

From the above trials, parental evaluation of potato tubers and production of seed tuber from TPS are the major portion of the research while the other trials contribute to increasing the survival value of the seedlings and thereby increasing yield.

Through years of research, potential parents with more than 70% uniform characteristics have been identified such as Al-204, Al-624, 457B Al-461 etc.

Production of seed tubers from TPS in nursery beds results in first generation tubers and these tubers could be multiplied for seed production and/or for consumption. Trials on $10m^2$ nursery plot at the College of Agriculture produced seed tubers of different sizes which will be enough to plant an area of more than 155 square meters. In terms of yield from 10 m^2 nursery bed, more than 80 kgs of seed tubers were harvested.

The combined method of TPS and seed tubers offers the potato grower considerable flexibility. Multiplication of the small seed tubers is attractive because of the favorable multiplication rate and the high health standard of the tubers.

Therefore, to exploit the merits of TPS production, additional stations should be established and priority problems in TPS production considered such as control of number and size of tubers, multiplication of first generation tubers, agronomic practices, etc.

SUMMARY AND CONCLUSION

One of the main reasons for the low yields of potatoes is that presently the farmers use local or land varieties which are poor yielders and not resistant to diseases, especially late blight. This is one of the problems which has forced some farmers to abandon the production of potatoes and resort to other vegetable or cereal crops.

As a result of continuous evaluation, seven best performing selection (B 5504, Anita, Kenya-Baraka, Spunta, BR-114-70, BR-114-39, BR-114-32) were given to the Horticultural Development Department in Ethiopia in 1981 for multiplication. However, some of the released varieties lost their resistance to late blight through time and were thus banned from production. The released varieties are not yet in the hands of the farmers, the reason being that there is not any government institution or agency which is mandated to multiply the seeds to improved varieties at the national level.

To improve the present state as far as lack of improved varieties and certified seeds is concerned, the following is recommended:

a. Full technical and financial support should be given to intensify research work in screening for high-yielding and disease resistant varieties with good adaptability to the potato growing regions.

b. Establishment of close collaboration with all concerned institutions agencies etc, and thereby intensify on-farm potato research activities in order to disseminate research results under the title of "Optimizing Potato Production" in the country.

c. In order to supply farmers with improved seed potatoes, a well coordinated national seed potato production scheme should be established.

Table 1: Pre-National Yield Trial (PNYT), 1983.

No.	Selection	Skin color (1)	Eye depth (2)	Size of tuber (3)	Set of tuber Per hill (4)	Shape of tuber (5)	Late blight (6)	Yield t/ha	Rank
1	A1-122	W	-	0	0	0	2	24.40	13
2	A1-121	W	0	0	-	FR	1	22.20	17
3	A1-280	W	-	0	0	0	2	22.92	16
4	A1-256	W	0	0	0	0	3	21.94	18
5	A1-216	W	0	0	-	0	4	15.81	21
6	A1-268	W	0	0	0	R	2	27.32	10
7	A1-201	R	-	0	-	0	4	15.92	20
8	A1-313	W	0	0	-	0	3	25.47	12
9	A1-335	W	0	+	0	FR	3	28.07	7
10	A1-443	R	0	+	0	FR	4	34.07	4
11	A1-437	P	0	0	0	FR	4	18.51	19
12	A1-401 B	W	0	0	-	FR	4	11.36	23
13	A1-471	W	0	0	-	FR	4	12.74	22
14	A1-458 B	W	0	+	0	R	3	28.91	6
15	A1-455	W	-	0	0	0	3	23.82	14
16	A1-416 B	W	0	0	0	0	3	26.21	11
17	A1-635	W	0	0	0	R	4	27.21	8
18	A1-421	W	0	-	-	R	4	4.91	24
19	A1-271	R	0	0	+	R	4	29.10	5
20	CIP-378371-4	W	+	+	+	FR	3	38.96	3
21	CIP-378371-5	W	0	+	+	FR	1	39.85	2
22	CIP-378371-8	W	+	+	0	FR	2	27.81	9
23	CIP-378601-7	R	0	+	+	FR	1	40.37	1
24	CIP-378371-23	W	0	0	0	FR	3	23.07	15

Key

1. R= Red, W= White, P= Pink, B= Black
2. + = deep eye, o = medium, - = shallow
3. + = large, 0 = medium, - = small
4. + = high, 0 = medium, - = low
5. R = Round, F = Falt, 0 = oval, FR = flat rou.
6. Scale: 1 = 25%, 2 = 50%, 3 = 75%, 4 = 100% of foliage damage

Table 2: Summary of national yield trial at Alemaya, Tuber yield (tons/ha).

	Cultivars	Year 1980	1981	1982	1983	1984	Average yield	Average* LB reaction	Rank
1	A1-148	28.42	35.29	22.23	6.07	-	23.00	1	5
2	A1-204	-	28.66	25.42	6.10	-	20.06	1	13
3	A1-253	44.21	25.75	35.29	6.83	24.67	27.35	2	2
4	A1-257	25.72	22.91	22.84	5.23	-	19.17	3	14
5	A1-563	41.81	11.37	21.87	5.49	-	20.13	4	12
6	A1-556	-	16.84	20.84	8.34	20.68	16.67	4	17
7	A1-517	44.81	10.54	-	7.06	21.33	20.93	3	10
8	A1-578	-	12.41	33.96	5.02	-	17.13	3	16
9	A1-580	4.20	21.75	13.81	4.80	-	11.14	4	20
10	A1-108	-	21.62	15.02	-	28.46	21.70	2	8
11	A1-601	-	20.46	44.08	4.27	29.07	24.47	3	3
12	A1-615	34.70	17.85	32.69	7.25	11.64	20.82	3	11
13	A1-624	68.51	14.66	41.89	4.44	39.09	33.71	2	1
14	A1-646	17.80	11.90	22.41	4.21	-	14.08	3	19
15	A1-100	-	-	32.29	6.59	25.59	21.49	1	9
16	A1-264	-	-	47.41	6.10	18.68	24.06	1	4
17	A1-560	47.60	-	17.15	4.05	-	22.93	3	6
18	A1-528	-	-	21.45	8.83	21.98	17.41	3	15
19	A1-305	-	-	46.76	9.29	11.01	22.35	3	7
20	A1-Local check	-	16.29	33.84	11.41	2.35	15.97	4	18

* Late Blight (LB)

Scale	% foliage damage
0	0
1	25
2	50
3	75
4	100

Table 3: Summary of nationalyield trial at Debre Zeit, Tuber yield (tons/ha).

	Cultivars	1980	1981	1982	1983	Average* LB reaction	Average yield	Rank
1	A1-204	-	26.58	45.82	43.93	0	38.77	5
2	A1-556	-	49.56	20.40	18.75	3	29.58	11
3	A1-253	12.85	41.95	41.38	33.48	3	32.41	8
4	A1-601	-	73.10	49.17	23.32	2	48.53	1
5	A1-624	19.52	64.76	50.50	30.85	2	41.40	4
6	A1-264	20.95	-	41.12	14.46	0	25.51	13
7	A1-517	19.52	45.23	-	27.75	3	30.83	10
8	A1-563	18.57	58.42	10.36	17.00	4	26.08	12
9	A1-615	19.52	75.41	44.96	33.90	3	43.44	2
10	A1-148	19.04	68.34	35.87	45.45	0	42.17	3
11	A1-646	13.80	59.72	38.34	33.90	3	36.44	7
12	A1-257	16.66	46.45	27.35	36.36	2	31.70	9
13	A1-560	17.61	-	7.99	18.18	4	14.59	16
14	A1-580	14.28	57.00	7.90	20.40	4	24.89	14
15	A1-578	20.95	40.56	46.96	38.32	3	36.69	6
16	A1-Local check	-	24.60	25.29	12.07	4	20.65	15

*Late Blight (LB)

Scale	% foliage damage
0	0
1	25
2	50
3	75
4	100

Table 4: Summary of national yield trial at Holetta, Tuber yield (tons/ha).

	Cultivars	1980	1981	1982	1983	Average yield	Average* LB reaction	Rank
1	A1-204	-	24.71	21.11	19.76	21.86	0	1
2	A1-253	15.71	20.66	16.82	13.02	16.55	3	5
3	A1-257	15.23	7.15	23.97	12.44	14.69	3	9
4	A1-148	17.14	23.07	16.88	11.93	17.25	0	3
5	A1-563	12.38	7.01	-	2.22	7.20	4	13
6	A1-624	25.32	23.60	18.71	11.06	19.67	2	2
7	A1-601	-	18.98	22.78	5.42	15.72	4	6
8	A1-615	15.23	18.18	20.61	14.37	17.09	3	4
9	A1-646	5.71	19.72	19.29	6.25	12.74	4	10
10	A1-556	-	17.04	5.47	6.68	9.73	4	12
11	A1-578	-	19.05	22.16	5.0	15.40	4	8
12	A1-517	17.61	20.60	-	8.15	15.45	3	7
13	A1-580	14.28	18.49	-	3.22	11.99	4	11
14	A1-Local check	-	4.70	5.41	3.86	4.65	4	14

* Late Blight (LB)

Scale	% foliage damage
0	0
1	25
2	50
3	75
4	100

Table 5: Summary of national yield trial at Bako, Tuber yield (ton/ha).

	Cultivars	1980	1981	1982	1983	Average yield	Average * LB reaction	Rank
1	Al-148	14.76	36.37	21.84	12.28	21.31	0	9
2	Al-204	-	35.21	16.73	21.10	24.34	1	7
3	Al-253	16.19	25.71	14.36	15.49	17.93	3	12
4	Al-556	-	32.18	13.88	25.74	23.93	3	8
5	Al-563	8.57	-	13.91	16.08	12.85	4	15
6	Al-578	-	37.50	31.80	28.02	32.44	3	2
7	Al-580	13.33	25.89	13.26	19.69	18.04	4	11
8	Al-601	-	27.15	43.59	23.10	34.28	3	1
9	Al-517	10.00	31.38	19.52	20.95	20.46	3	10
10	Al-624	14.28	31.87	44.95	19.40	27.62	3	5
11	Al-615	30.00	26.81	38.27	23.85	29.73	3	4
12	Al-634	13.33	38.80	28.59	-	26.90	3	6
13	Al-575	14.28	11.45	12.29	-	12.67	4	16
14	Al-257	9.04	24.25	17.40	10.51	15.30	3	13
15	Al-646	42.85	37.50	33.07	13.22	31.66	2	3
16	Local check	-	14.18	11.45	14.41	13.34	4	14

* Late Blight (LB)

Scale	% foliage damage
0	0
1	25
2	50
3	75
4	100

Table 6: Mean yield of the national yield trial at Alemaya, Bako, Debre Zeit and Holetta from 1980-1983(ton/ha)

	Cultivars	Alemaya	Bako	Debre Zeit	Holetta	Average yield	Rank
1	A1-148	23.00	21.31	42.17	17.25	25.93	5
2	A1-204	20.06	24.34	38.77	21.86	26.25	4
3	A1-253	27.35	17.93	32.41	16.55	23.56	8
4	A1-563	20.13	12.85	26.08	7.20	16.56	12
5	A1-556	16.67	23.93	29.57	9.73	19.97	11
6	A1-578	17.13	32.44	36.69	15.40	25.41	6
7	A1-601	24.47	34.28	48.53	15.72	30.75	1
8	A1-615	20.82	29.73	43.44	17.00	27.74	3
9	A1-624	33.71	27.62	41.40	19.67	30.60	2
10	A1-257	19.17	15.30	31.70	14.69	20.21	10
11	A1-517	20.93	20.46	30.83	15.45	21.91	9
12	A1-580	11.14	18.04	24.89	11.99	16.51	13
13	A1-646	14.08	31.66	36.44	12.74	23.73	7
14	Local check	15.97	13.34	20.65	3.86	13.45	14